

SCIENCE

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FRIDAY, JANUARY 31, 1896.

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THE SMITHSONIAN INSTITUTION.

THE annual meeting of the Board of Regents of the Smithsonian Institution was held Wednesday, January 22d, at 10 o'clock.

The Vice-President, Hon. Melville W. Fuller, Chief Justice of the United States, Postmaster General Wilson, Senator Justin S. Morrill, Senator Shelby M. Cullom, Senator George Gray, Representative Joseph Wheeler, Representative R. R. Hitt, Representative Robert Adams, Jr., Dr. A. D. White, General J. B. Henderson and Hon. Gardiner G. Hubbard.

The death of Doctor Henry Coppee, President of Lehigh University, long a member of the Board, was announced and appropriate resolutions adopted.

An Executive Committee was appointed as follows: Hon. John B. Henderson, Chairman; Hon. William L. Wilson and Hon. Gardiner G. Hubbard.

Secretary Langley presented his annual report, in which the chief events of importance during the past year were discussed. Allusion was made to the conferring of the Hodgkins Fund prize of \$10,000, and to the transmission of the amount of the award through the American embassy in London to Lord Rayleigh and Professor Ramsay; also to the fact that a similar prize for the same discovery has recently been given to the same persons by the Institute of France. The prize of \$1,000 was given to M. de Va-

rigny, of Paris, for the best popular treatise in accordance with the terms of the announcement, and three silver and six bronze medals awarded to the laureates out of nearly 200 contestants. The medals which have been designed by Mons. T. C. Chaplain, a member of the French Institute and the most famous medalist in the world, are being struck at the government mint in Paris and will soon be ready for distribution.

The Secretary expressed the opinion that the giving of a large prize having served its purpose in attracting the attention of the world to the Hodgkins Fund and the purposes of its founder, it would probably not be wise to offer at present additional large prizes of this kind, since these have rarely been found efficacious in stimulating discovery; and that hereafter the income should be spent directly in aid of investigations in regard to the atmosphere and its properties.

Speaking of the Hodgkins bequest, Secretary Langley dwelt upon the idea that the foresight of Mr. Hodgkins has been in one particular remarkably justified, since the experience of the last three years has shown that there is no department in the field of human thought, apart from such abstract ones as æsthetics, higher mathematics, logic and the like, which does not come under the purview of this donation; so that the restriction of the income from this \$100,000 of the bequest to the special purpose of investigations regarding atmospheric air is in reality no embarrassment or limitation of the free activities of the Institution.

Attention was also directed to the recent bequest of Mr. Robert Stanton Avery, of Washington, the value of which has been estimated at \$50,000, but which it seems probable will not prove to be nearly so large.

The present year, 1896, being the fiftieth since the foundation of the Institution, the occasion will be celebrated by the erection

of bronze tablets to the memory of the founder, James Smithson, upon his tomb in the English cemetery in Genoa, and also in the English church in the same city. A preliminary design of this tablet by Mr. William Ordway Partridge was submitted for inspection.

There will also be published a semi-centennial volume, giving an account of the origin of the Institution and summing up the results of its fifty years' activities in every department of science. This volume will be handsomely printed, in an edition sufficiently large to supply all the principal libraries of the world; and will contain portraits of the founder; the Chancellors—George M. Dallas, Millard Fillmore, Roger B. Taney, Salmon P. Chase, Morrison R. Waite and Melville W. Fuller; and those of the regents who have contributed most materially to the development and influence of the Institution, such as James A. Pierce, Alexander Dallas Bache, Louis Agassiz and George Bancroft. Chapters will be contributed by a considerable number of the most prominent scientific men and educators of the United States.

Allusion was made by the Secretary to the table at the Zoölogical Station at Naples, rented by the Institution for the benefit of investigators and students of American natural history, and to the fact that the popularity of this undertaking is so great that petitions from eight of the principal natural history societies of the country, four of them national, including together some 3,000 members, and a petition signed by 200 of the principal naturalists of the country, have been received, urging their continuance of the table for another period of three years.

The Secretary also called attention to the crowded condition of the National Museum and the necessity of new buildings, not only for the exhibition of collections, but for the storage of material now placed in temporary

sheds near the building of the Institution, which, being inflammable, are a constant menace to its safety.

The Bureau of Ethnology is continuing its important work in the study of linguistics, habits and customs of the American aborigines, and important explorations have been made during the year under the direction of Mr. McGee among the Seri and Papago Indians, of the far Southwest, and by Dr. J. Walter Fewkes in the ruins of a town near Moqui, which was destroyed by hostile Indians before the first visit of the Spaniards. The latter exploration was the first ever made of a thoroughly pre-Columbian town site, and resulted in the gathering of a collection of pottery and other objects of unequalled beauty and value.

Referring to the Zoölogical Park, Secretary Langley directed attention to the alarming reports which are coming from the Yellowstone National Park, which seem to make it certain that the herd of several hundred buffalo reported last year has been reduced to fifty or less, and indicating that it will soon be destroyed unless steps are taken for its preservation. Since the means at the disposal of the custodians of the Yellowstone National Park seem quite inadequate to protect them, the desirability is suggested of transferring most of the remnant of the herd to Washington, to be placed in the Zoölogical Park, which has amply sufficient space for all that are left.

The work of the Astro-Physical Observatory was referred to, and the researches there being carried on, which are giving us a knowledge of nearly thrice the amount of details of solar energy that were known to Sir Isaac Newton, and in a region which was left almost untouched until our own day when these researches took it up. The number of known lines in this portion of the spectrum has increased from less than twenty to over a thousand owing to the

work which has been carried on in this little observatory during the last four years. The location is a very unfortunate one, however, since the traffic of the street interferes with the proper use of the instruments, and reference was made by the Secretary to a plan for constructing a modest building for this work in some portion of the suburbs where the necessary quiet can be obtained.

The Secretary's report was accepted, as was also that of the Executive Committee.

Letters of acknowledgment were read from the Royal Institute of Great Britain for a portrait of Mr. Hodgkins sent by the Institution, and from the master of Pembroke College in Oxford, where Smithsonian received his degree in 1786, acknowledging the gift of a complete series of the publications of the Institution.

*MEMORIAL TRIBUTE TO PROFESSOR THOMAS H. HUXLEY.**

ALL the members of this Academy, in fact all men of science in America, are in different ways indebted to the late Professor Huxley. We should be ungrateful, indeed, especially in this section of the Academy, if we failed to join in the tributes which are being paid to him in different parts of the world.

In his memory I do not offer a formal address this evening, but, as one of his students, would present some personal reminiscences of his characteristics as a teacher, and some of the striking features of his life and work.

Huxley was born in 1825. Like Goethe, he inherited from his mother his brilliantly alert powers of thought, and from his father his courage and tenacity of purpose, a combination of qualities which especially fitted him for the period in which he was to live. There is nothing striking recorded about his boyhood as a naturalist. He preferred engineering, but was led into medicine.

* Read before the Biological Section of the New York Academy of Sciences, November 11, 1895.

At the close of his medical course he secured a navy medical post upon the 'Rattlesnake.' This brought with it, as to Darwin, the training of a four-years' voyage to the South Seas off eastern Australia and west Guinea—a more liberal education to a naturalist than any university affords, even at the present day. This voyage began at twenty-one, and he says of it: "But, apart from experience of this kind and the opportunity afforded for scientific work to me, personally, the cruise was extremely valuable. It was good for me to live under sharp discipline, to be down on the realities of existence by living on bare necessities, to find out how extremely worth living life seemed to be, when one woke from a night's rest on a soft plank, with the sky for a canopy and cocoa and weevily biscuit the sole prospect for breakfast, and more especially to learn to work for what I got for myself out of it. My brother officers were as good as sailors ought to be and generally are, but naturally they neither knew nor cared anything about my pursuits, nor understood why I should be so zealous in the pursuit of the objects which my friends, the mid-dies, christened 'Buffons,' after the title conspicuous on a volume of the '*Suites a Buffon*,' which stood in a prominent place on my shelf in the chart room."

As the result of this voyage of four years numerous papers were sent home to the Linnæan Society of London, but few were published; upon his return his first great work, *Upon the Anatomy and Affinities of the Medusæ*, was declined for publication by the Admiralty—a fortunate circumstance, for it led to his quitting the navy for good and trusting to his own resources. Upon publication, this memoir at once established his scientific reputation at the early age of twenty-four, just as Richard Owen had won his spurs by his 'Memoir on the Pearly Nautilus.' In 1852 Huxley's preference as a biologist was to turn back to physiology,

which had become the favorite study of his medical course. But his fate was to enter and become distinguished in a widely different branch, which had as little attraction for him as for most students of marine life, namely, paleontology. He says of his sudden change of base:

"At last, in 1854, on the translation of my warm friend, Edward Forbes, to Edinburgh, Sir Henry de la Beche, the Director-General of the Geological Survey, offered me the post Forbes had vacated of Paleontologist and Lecturer on Natural History. I refused the former point-blank, and accepted the latter only provisionally, telling Sir Henry that I did not care for fossils and that I should give up natural history as soon as I could get a physiological post. But I held the office for thirty-one years and a large part of my work has been paleontological."

From this time until 1885 his labors extended over the widest field of biology and of philosophy ever covered by any naturalist, with the single exception of Aristotle. In philosophy Huxley showed rare critical and historical power; he made the most exhaustive study of Hume, but his own philosophical spirit and temper was more directly the offspring of Descartes. Some subjects he mastered, others he merely touched, but every subject which he wrote about he illuminated. Huxley did not discover or first define protoplasm, but he made it known to the English-speaking world as the physical basis of life; recognizing the unity of animal and plant protoplasm. He cleared up certain problems among the *Protozoa*. In 1849 appeared his great work upon the oceanic *Hydrozoa*, and familiarity with these forms doubtless suggested the brilliant comparison of the two-layered gastrula to the adult hydrozoa. He threw light upon the Tunicata, describing the endostyle as a universal feature, but not venturing to raise the Tunicata to a

separate order. He set in order the cephalopod mollusca, deriving the spiral from the straight shelled fossil forms. He contributed to the Arthropoda; his last word upon this group being his charming little volume upon the 'Crayfish,' a model of its kind. But think of the virgin field which opened up before him among the vertebrata, when in 1859 he was the first to perceive the truth of Darwin's theory of descent. Here were Cuvier's and Owen's vast researches upon living and extinct forms, a disorderly chaos of facts waiting for generalization. Huxley was the man for the time. He had already secured a thoroughly philosophical basis for his comparative osteology by studying the new embryology of Von Baer, which Richard Owen had wholly ignored. In 1858 his famous Croonian lecture on the 'Theory of the Vertebrate Skull' gave the death blow to Owen's life work upon the skull and vertebral archetype, and to the whole system of mystical and transcendental anatomy; and now Huxley set to work vigorously to build out of Owen's scattered tribes the great limbs and branches of the vertebrate tree. He set the fishes and batrachia apart as the *Ithyopsidan* branch, the reptiles and birds as the *Sauropsidan* in contrast with the *Mammalian*, which he derived from a pro-sauropsidan or amphibian stem, a theory which with some modification has received strong recent verification.

Prof. Owen, who had held undisputed sway in England up to 1858, fought nobly for opinions which had been idolized in the first half century, but was routed at every point. Huxley captured his last fortress, when, in his famous essay of 1865, 'Man's Place in Nature,' he undermined Owen's teaching of the separate and distinct anatomical position of Man. We can only appreciate Huxley's fighting qualities when we see how strongly Owen was intrenched at the beginning of this long battle royal;

he was director of the British Museum and occupied other high posts; he had the strong moral support of the government and of the royal family, although these were weak allies in a scientific encounter.

Huxley's powers of rapid generalization of course betrayed him frequently; his *Bathybius* was a groundless and short-lived hypothesis; he went far astray in the phylogeny of the horses. But these and other errors were far less attributable to defects in his reasoning powers than to the extraordinarily high pressure under which he worked for the twenty years between 1860 and 1880, when duties upon the Educational Board, upon the Government Fisheries Commission and upon Parliamentary committees crowded upon him. He had at his command none of the resources of modern technique. He cut his own sections. I remember once seeing some of his microscopic sections. To one of our college junior students working with a Minot microtome Huxley's sections would have appeared like translucent beefsteaks—another illustration that it is not always the section which reveals the natural law, but the man who looks at the section.

Huxley was not only a master in the search for truth, but in the way in which he presented it, both in writing and in speaking. And we are assured, largely as he was gifted by nature, his beautifully lucid and interesting style was partly the result of deliberate hard work. He was not born to it; some of his early essays are rather labored; he acquired it. He was familiar with the best Greek literature and restudied the language; he pored over Milton and Carlyle and Mill; he studied the fine old English of the Bible; he took as especial models Hume and Hobbes, until finally he wrote his mother tongue as no other Englishman wrote it. Take up any one of his essays, biological, literary, philosophical, you at once see his central idea and his

main purpose, although he never uses italics or spaced letters, as many of our German masters do to relieve the obscurity of their sentences. We are carried along upon the broad current of his reasoning without being confused by his abundant side illustrations. He gleaned from the literature of all time until his mind was stocked with apt similes. Who but Huxley would have selected the title 'Lay Sermons' for his first volume of addresses; or, in 1880, twenty-one years after Darwin's work appeared, would have entitled his essay upon the influence of this work: 'The Coming of Age of the Origin of Species?' Or to whom else would it have occurred to repeat over the grave of Balfour the exquisitely appropriate lines: 'For Lycidas is dead, dead ere his prime.' Who else could have inveighed thus against modern specialization: "We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines and was crushed by the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrow specialist as time goes on. It appears to me that the only defense against this tendency to the degeneration of scientific workers lies in the organization and extension of scientific education in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness."

Huxley's public addresses always gave the impression of being largely impromptu, but he once told me: "I always think out carefully every word I am going to say. There is no greater danger than the so-called *inspiration of the moment*, which leads

you to say something which is not exactly true, or which you would regret afterward. I sometimes envy your countrymen their readiness and believe that a native American, if summoned out of bed at midnight, could step to his window and speak well upon any subject." I told him I feared he had been slightly misinformed; I feared that many American impromptu speeches were more distinguished by a flow of language than of ideas. But Huxley was sometimes very impressive when he did not speak. In 1879 he was strongly advocating the removal of the Royal School of Mines from crowded Jermyn street to South Kensington, a matter which is still being agitated. At a public dinner given by the alumni of the School, who were naturally attached to the old buildings, the chairman was indiscreet enough to make an attack upon the policy of removal. He was vigorously applauded, when, to every one's consternation, Huxley, who was sitting at the chairman's right, slowly rose, paused a moment, and then silently skirted the tables and walked out of the hall. A solemn pall fell over the remainder of the dinner and we were all glad to find an excuse to leave early.

In personal conversation Huxley was full of humor and greatly enjoyed stories at his own expense. Such was the following: "In my early period as a lecturer I had very little confidence in my general powers, but one thing I prided myself upon was clearness. I was once talking of the brain before a large mixed audience and soon began to feel that no one in the room understood me. Finally I saw the thoroughly interested face of a woman auditor and took consolation in delivering the remainder of the lecture directly to her. At the close, my feeling as to her interest was confirmed when she came up and asked if she might put one question upon a single point which she had not quite understood. 'Certainly,' I replied. 'Now, Professor,' she said, 'is

the cerebellum inside or outside of the skull?" "A story of his about babies is also characteristic: "When a fond mother calls upon me to admire her baby I never fail to respond, and, while cooing appropriately, I take advantage of an opportunity to gently ascertain whether the soles of its feet turn in and tend to support my theory of arboreal descent."

Huxley as a teacher can never be forgotten by any of his students. He entered his lecture room promptly as the clock was striking nine, rather quickly and with his head bent forward 'as if oppressive with its mind.' He usually glanced attention to his class of about ninety and began speaking before he reached his chair. He spoke between his lips, but with perfectly clear analysis, with thorough interest and with philosophic insight, which was far above the average of his students. He used very few charts, but handled the chalk with great skill, sketching out the anatomy of an animal as if it were a transparent object. As in Darwin's face, and as in Erasmus Darwin's or Buffon's, and many other anatomists with a strong sense of form, his eyes were heavily overhung by a projecting forehead and eyebrows and seemed at times to look inward. His lips were firm and closely set, with the expression of positiveness, and the other feature which most marked him was the very heavy mass of hair falling over his forehead, which he would frequently stroke or toss back. Occasionally he would lighten up the monotony of anatomical description by a bit of humor. I remember one instance which was probably reminiscent of his famous tilt with Bishop Wilberforce at the meeting of the British Association in 1860. Huxley was describing the mammalian heart and had just distinguished between the tricuspid valve on the right side of the heart and the bicuspid valve on the left, which you know resembles a bishop's mitre, and hence is known as the

mitral valve. He said, "It is not easy to recall on which side these respective valves are found, but I recommend this rule; you can easily remember that the mitral is on the left, because a bishop is never known to be on the right."

Huxley was the father of modern laboratory instruction, but in 1879 he was so intensely engrossed with his own researches that he very seldom came through the laboratory, which was ably directed by T. Jeffrey Parker, assisted by G. B. Howes and W. Newton Parker, all of whom are now professors, Howes having succeeded to Huxley's chair. Each visit therefore inspired a certain amount of terror, which was really unwarranted, for Huxley always spoke in the kindest tones to his students, although sometimes he could not resist making fun at their expense. There was an Irish student who sat in front of me, whose anatomical drawings in water color were certainly most remarkable productions. Huxley, in turning over his drawing-book, paused at a large blur under which was carefully inscribed 'sheep's liver' and smilingly said, "I am glad to know that is a liver; it reminds me as much of Cologne cathedral in a fog as of anything I have ever seen before." Fortunately the nationality of the student enabled him to fully appreciate the humor.

The greatest event in the winter of 1879 was Darwin's first and only visit to the laboratory. They came in together, Huxley leading slowly down the long, narrow room, pointing out the especial methods of teaching, which he had originated and which are now universally adopted in England and in this country. Darwin was instantly recognized by the class as he entered and sent a thrill of curiosity down the room, for no one present had ever seen him before. There was the widest possible contrast in the two faces. Darwin's grayish-white hair and bushy eyebrows overshadowed the pair of deeply-set blue eyes, which

seemed to image his wonderfully calm and deep vision of nature and at the same time to emit benevolence. Huxley's piercing black eyes and determined and resolute face were full of admiration, and, at the same time, protection of his older friend. He said afterwards, "you know I have to take care of him, in fact, I have always been Darwin's bulldog," and this exactly expressed one of the many relations which existed so long between the two men.

Huxley was not always fortunate in the intellectual calibre of the men to whom he lectured in the Royal School of Mines. Many of the younger generation were studying in the universities, under Balfour at Cambridge, and under Rolleston, at Oxford. However, Saville Kent, C. Lloyd Morgan, George B. Howes, T. Jeffrey Parker and W. Newton Parker are representative biologists who were directly trained by Huxley. Many others, not his students, have expressed the deepest indebtedness to him. Among these especially are Prof. E. Ray Lankester, of Oxford, and Prof. Michael Foster, of Cambridge. Huxley once said that he had 'discovered Foster.' He not only singled men out, but knew how to direct and inspire them to investigate the most pressing problems of the day. As it was, his thirty-one years of lectures would have produced a far greater effect if they had been delivered from an Oxford, Cambridge or Edinburgh chair. In fact, Huxley's whole life would have been different, in some ways more effective, in others less so, if the universities had welcomed the young genius who was looking for a post and even cast his eyes toward America in 1850, but in those early days of classical prestige both seats of learning were dead to the science which it was Huxley's great service in support of Darwin to place beside physics, in the lead of all others in England. Moreover, Oxford, if not Cambridge, could not long have sheltered such a wolf in the fold.

What Haeckel did for evolution in Germany, Huxley did in England. As the earliest and most ardent supporter of Darwin and the theory of descent, it is remarkable that he never gave an unreserved support to the theory of natural selection as all-sufficient. Twenty-five years ago, with his usual penetration and prophetic insight, he showed that the problem of variation might, after all, be the greater problem; and only three years ago, in his 'Romanes Lecture,' he disappointed many of the disciples of Darwin by declaring that natural selection failed to explain the origin of our moral and ethical nature. Whether he was right or wrong, we will not stop to discuss, but consider the still more remarkable conditions of Huxley's relations to the theory of evolution. As expositor, teacher, defender, he was the high priest of evolution. From the first he saw the strong and weak points of the special Darwinian theory; he wrote upon the subject for thirty years, and yet he never contributed a single original or novel idea to it; in other words, Huxley added vastly to the demonstration, but never added to the sum of either theory or working hypothesis, and the contemporary history of the theory proper could be written without mentioning his name. This lack of speculation upon the factors of evolution was true throughout his whole life; in the voyage of the 'Rattlesnake' he says he did not even think of the species problem. His last utterance regarding the causes of evolution appeared in one of the Reviews as a passing criticism of Weismann's finished philosophy, in which he implies that his own philosophy of the causes of evolution was as far off as ever; in other words, Huxley never fully made up his mind or committed himself to any causal theory of development.

Taking the nineteenth century at large, outside of our own circles of biology, Huxley's greatest and most permanent achievement was his victory for free thought. Per-

sonally we may not be agnostic ; we may disagree with much that he has said and written, but we must admire Huxley's valiant services none the less. A reformer must be an extremist, and Huxley was often extreme, but he never said what he did not believe to be true. If it is easy for you and for me to say what we think, in print and out of print now, it is because of the battles fought by such men as Huxley and Haeckel. When Huxley began his great crusade the air was full of religious intolerants, and, what is quite as bad, scientific shams. If Huxley had entered the contest carefully and guardedly, he would have been lost in the enemies' ranks, but he struck right and left with sledge hammer blows, whether it was a high dignity of the Church or of the State. Just before the occasion of one of his greatest contests, that with Gladstone in the pages of the *Contemporary Review*, Huxley was in Switzerland, completely broken down in health and suffering from torpidity of the liver. Gladstone had written one of his characteristically brilliant articles upon the close correspondence between the Order of Creation as revealed in the first chapter of Genesis and the Order of Evolution as shown by modern biology. "When this article reached me," Huxley told me, "I read it through and it made me so angry that I believe it must have acted upon my liver. At all events, when I finished my reply to Gladstone I felt better than I had for months past."

Huxley's last public appearance was at the meeting of the British Association at Oxford. He had been very urgently invited to attend, for, exactly a quarter of a century before, the Association had met at Oxford and Huxley had had his famous encounter with Bishop Wilberforce. It was felt that the anniversary would be an historic one and incomplete without his presence, and so it proved to be. Huxley's especial duty was to second the vote of thanks for the

Marquis of Salisbury's address—one of the invariable formalities of the opening meeting of the Association. The meeting proved to be the greatest one in the history of the Association. The Sheldonian theatre was packed with one of the most distinguished scientific audiences ever brought together, and the address of the Marquis was worthy of the occasion. The whole tenor of it was the unknown in Science. Passing from the unsolved problems of Astronomy, Chemistry and Physics, he came to Biology. With delicate irony he spoke of the '*comforting word, evolution,*' and passing to the Weismannian controversy implied that the diametrically opposed views so frequently expressed nowadays threw the whole process of evolution into doubt. It was only too evident that the Marquis himself found no comfort in Evolution, and even entertained a suspicion as to its probability. It was well worth the whole journey to Oxford to watch Huxley during this portion of the address. In his red doctor-of-laws gown, placed upon his shoulders by the very body of men who had once referred to him as 'a Mr. Huxley,' he sank deeper into his chair upon the very front of the platform and restlessly tapped his foot. His situation was an unenviable one. He had to thank an ex-Prime Minister of England and present Lord Chancellor of Oxford University for an address, the sentiments of which were directly against those he himself had been maintaining for twenty-five years. He said afterwards that when the proofs of the Marquis' address were put in his hands the day before, he realized that he had before him a most delicate and difficult task.

Lord Kelvin, one of the most distinguished living physicists, first moved the vote of thanks, but his reception was nothing to the tremendous applause which greeted Huxley in the heart of that University whose traditional principles he had so long been opposing. Considerable anx-

ity had been felt by his friends lest his voice would fail to fill the theatre, for it had signally failed during the Romanes Lecture delivered in Oxford the year before, but when Huxley arose he reminded you of a venerable gladiator returning to the arena after years of absence. He raised his figure and his voice to its full height, and, with one foot turned over the edge of the step, veiled an unmistakable and vigorous protest in the most gracious and dignified speech of thanks.

Throughout the subsequent special sessions of this meeting Huxley could not appear. He gave the impression of being aged, but not infirm, and no one realized that he had spoken his last word as champion of the law of Evolution. He soon returned to Eastbourne. Early in the winter he contracted the gripe, which passed into pneumonia. He rallied once or twice, and his last effort to complete a reply to Balfour's 'Foundations of Belief' hastened his death, which came upon June 29th, at the age of seventy.

I have endeavored to show in how many ways Huxley was a model for us of the younger generation. In the central hall of the British Museum of Natural History sits in marble the life-size figure of Charles Darwin; upon his right will soon be placed a beautiful statue of Richard Owen, and I know that there are many who will enjoy taking some share in the movement to complete this group with the noble figure of Thomas Henry Huxley.

HENRY F. OSBORN.

COLUMBIA COLLEGE.

ON THE CLASSIFICATION OF MUSEUMS.*

MUSEUMS may best be classified in two ways; by the character of their contents,

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and by the purposes for which they are founded.*

Under the first category they may be grouped as follows:

- A. Museums of Art.
- B. Historical Museums.
- C. Anthropological Museums.
- D. Natural History Museums.
- E. Technological Museums.
- F. Commercial Museums.

Under the second category they may be classed as

- G. National Museums.
- H. Local, Provincial or City Museums.
- I. College and School Museums.
- J. Professional or Class Museums.
- K. Museums or Cabinets for special research owned by societies or individuals.

A. Art Museums.

1. The Museum of Art is a depository for the æsthetic products of man's creative genius, such as paintings, sculptures, architecture (so far as it can be shown by models, drawings and structural fragments) and specimens of the illustrative arts (such as engravings) and illustrations of the application of art to decorative uses.

2. The greater art collections illustrate, in a manner peculiarly their own, not only the successive phases in the intellectual progress of the civilized races of man, their sentiments, passions and morals, but also their habits and customs, their dress, implements and the minor accessories of their culture often not otherwise recorded.

3. Museums of art, wherever they may be situated, have a certain general similarity to each other in purpose, contents and method of management. Those which most fully represent the art of the communities

*In the references to special museums nothing has been further from my idea than to catalogue existing museums. Many of the most important are not even referred to by name. I have spoken only of those which are especially familiar to myself and which seem best to illustrate the idea in connection with which they are named.

to which they belong, other things being equal, are the most useful and are usually the most famous.

[Since the founding in Florence by Cosmo de'Medici, at the beginning of the sixteenth century, of the Museum of the Uffizi, perhaps the oldest museum of art now in existence, every great city in the civilized world has become the seat of a museum or gallery of art. Besides the great general collections of art, there are special museums devoted to the work of single masters, such as the Thorwaldsen Museum in Copenhagen, and the one at Brussels containing only the works of the eccentric painter, Wiertz; the Donatello Museum in the Bargello at Florence, and the Michael Angelo collections in the Florence Academy of Fine Arts and in the Casa Buonarrotti.]

B. Historical Museums.

1. The Museum of History preserves those material objects which are associated with events in the history of individuals, nations or races, or which illustrate their condition at different periods in their national life.

2. Every museum of art and every archaeological museum is also a museum of history, since it contains portraits of historical personages, pictures of historical events, and delineations of customs, costumes, architecture and race characteristics.

[Historical museums are manifold in character, and of necessity local in interest. Some relate to the histories of provinces and cities. One of the oldest and best of these is the Provincial Museum of the Mark of Brandenburg in Berlin. Of the same class are the Museum of the City of Paris in the Hotel Canavelet, and the museums of the City of Brussels and the City of Antwerp.

Others illustrate the early history of a race or country, such as the Musée Gallo-Romain at St. Germain, the Romano-German Museum at Mainz, the Etruscan Museums at Florence and Cologne, the Ghizeh Museum near Cairo, the Acropolis Museum at Athens, and the Museums in Constantinople.

Such institutions as the Bavarian National Museum at Nuremberg and the German National Museum in Munich have to do with later periods of history, and there are throughout Europe numerous collections of armor, furniture, costumes and architectural and other objects, illustrating the life and arts of the middle ages and the later periods, which are even more significant from the standpoint of the historian than from that of the artist. Important among these are the Royal Irish Academy in Dublin, and the Musée des Thermes—the 'Cluny Museum'—in Paris.

Many of the cathedrals of Europe are essentially either civic or national museums, and such edifices as Saint Paul's and Westminster Abbey belong preëminently to the latter class.

There are biographical museums, either devoted to single men—like the Galileo, Dante, and Buonarrotti Museums in Florence, or the Goethe Museum in Weimar, and the Beethoven Museum in Bonn; to the great men of a nation, as the National Portrait Gallery of Great Britain, the German Valhalla at Ratisbon, etc.; or to great men of a special profession, such as the Gallery of Artists in the Pitti Museum of Florence.

In this connection would come also collections of autographs and manuscripts (like the Dyce-Forster Collection at South Kensington), and collections of personal relics.

Midway between the Museum of History and that of Biography stands the Dynastic or Family Museum, such as the Museum of the Hohenzollerns in Berlin, and that section of the Kunsthistorisches Museum in Vienna, which illustrates the history of the Hapsburgs. The Musée Historique de Versailles is similar in its aims.]

C. Anthropological Museums.

1. The Museum of Anthropology includes such objects as illustrate the natural history of Man, his classification in races and tribes, his geographical distribution, past and present, and the origin, history and methods of his arts, industries, customs and opinions, particularly among primitive and semi-civilized peoples.

2. Museums of Anthropology and History meet on common ground in the field of

Archæology. In practice, Historical Archæology is usually assigned to the latter, and Prehistoric Archæology to the former. This is partly because Historic Museums, which are usually national in scope and supported on documentary evidence, treat the prehistoric races as extralimital; partly because prehistoric material is studied to best advantage through the natural history methods in use among anthropologists but not among historical students.

[Ethnographic Museums were proposed more than half a century ago by the French geographer Jomard, and the idea was first carried into effect about 1840 in the establishment of the Danish Ethnographical Museum. In Germany there are Anthropological Museums, in Berlin, Dresden and Munich, and the Museum für Völkerkunde in Leipsic; in Austria, the Court and the Oriental Museums in Vienna; in Holland, the National Ethnographical Museum in Leyden, and smaller ones in Amsterdam, Rotterdam and at The Hague; in France, the Trocadero; in Italy, the important Prehistoric and Ethnographic Museums in Rome and Florence; in Spain, the Phillippine Collections in the Museo de Ultramar in Madrid; and in Hawaii, the Bernice Pauahi Bishop Museum, at Honolulu.

In England less attention has been given to the subject than elsewhere in Europe, the Christy Collection in the British Museum, the Pitt-Rivers Collection at Oxford and the Blackmore Museum at Salisbury being the most important ones specially devoted to ethnography. In the United States, the Peabody Museum of Archæology in Cambridge, the collections in the Peabody Academy of Sciences at Salem, and the American Museum of Natural History in New York are arranged ethnographically, while the ethnological collections in the National Museum in Washington are classified on a double system, one with regard to race, the other, like the Pitt-Rivers Collection, intended to show the evolution or development of culture and civilization without regard to race. This broader plan admits much material excluded by the advocates of ethnographic museums, who devote their attention almost exclusively to the primitive or non-European peoples.

Closely related to the ethnographic museum are others devoted to some special field, such as the Musée Guimet in Paris, which is intended to illustrate the history of religious ceremonials among all races of men, a field also occupied by one department of the National Museum in Washington. Other good examples of this class are some of those in Paris, such as the Musée de Marine, which shows not only the development of the merchant and naval marines of the country, but also, by trophies and other historical souvenirs, the history of the naval battles of the Nation; and the Musée d'Artillerie, which has a rival in Madrid.

Of musical Museums, perhaps the most important are Clepissou's Musée Instrumental in Paris; that in Brussels and that in the National Museum at Washington. The collection of musical instruments at South Kensington has had its contents selected chiefly with reference to their suggestiveness in decorative art.

The Theatrical Museum at the Académie Française in Paris, the Museum of Journalism at Antwerp, the Museums of Pedagogy in Paris and St. Petersburg, are professional rather than scientific or educational, as are also the Museum of Practical Fish Culture at South Kensington, the Monetary Museum at the Paris Mint, the Museums of Hygiene in London and Washington and the United States Army Medical Museum.

The value of archæological collections, both historic and prehistoric has long been understood. The Museums of London, Paris, Berlin, Copenhagen and Rome need no comment. In the Peabody Museum in Cambridge, the American Museum in New York, the Museum of the University of Pennsylvania and the National Museum in Washington are immense collections of the remains of prehistoric man in America.]

D. Natural History Museums.

1. The Museum of Natural History is the depository for objects which illustrate the forces and phenomena of nature—the named units included within the three kingdoms, animal, vegetable and mineral,—and whatever illustrates their origin in time (or phylogeny), their individual origin, development, growth, function, structure,

and geographical distribution, past and present; also their relation to each other, and their influence upon the structure of the earth and the phenomena observed upon it!

2. Museums of Natural History and Anthropology meet on common ground in Man. In practice the former usually treats of man in his relations to other animals, the latter of man in his relations to other men.

[In most national capitals, there are general museums of natural history, in which collections representing the three kingdoms of nature are included in one group. Among the oldest and most prominent types of this class are the British Museum of Natural History in South Kensington and the Musée d'Histoire Naturelle in Paris, and there are numerous others in the great cities of both hemispheres.]

Among specialized natural history collections, a good type is the Museum of Comparative Zoölogy in Cambridge, Mass., founded by Agassiz to illustrate the history of Creation, as far as the present state of knowledge reveals the history, which was in 1887 pronounced by Alfred Russell Wallace to be far in advance of similar institutions in Europe, whether as regards the general public, the private student or the specialist.

Next in order after the Zoölogical Sections of the Museums in London and Paris, stand those of the Imperial Cabinet in Vienna; those in Berlin, Leyden, Copenhagen, Christiania, Brussels and Florence, and the La Plata Museum in Argentina, so rich in paleontological material.

The best type of the Botanical Museum is perhaps the Royal Garden at Kew, with its colossal herbarium and its special museum of economic botany, both standing in the midst of a great botanic garden. The Royal Botanical Museum in Berlin and the herbaria of the Imperial Botanical Garden in St. Petersburg are other examples.

Of specialized Geological Museums, the Imperial Cabinet in Vienna is a good type. The Museum of Practical Geology in London, founded to exhibit the collections of the Survey of the United Kingdom, and also in order to show the applications of geology to the useful processes of life, is another type of the same class.

The Department of Economic Geology in the Field Columbian Museum of Chicago, an outgrowth of the Exposition of 1893, represents this idea in the new world.

Besides the great special museums, there are the museums of local natural history, intended to show the natural history of a special region, or, it may be, to illustrate its resources in some restricted branch.

The Royal Museum of Vertebrates in Florence, devoted to the vertebrate fauna of Italy, is a type of this class, and many local museums are so prominent in some special field (such as ornithology or entomology) that their other activities attract little attention.]

E. Technological or Industrial Museums.

1. The Museum of Technology or Industrial Museum is devoted to the industrial arts and manufactures, including:

1. Materials and their sources.
2. Tools and machinery.
3. Methods and processes.
4. Products and results.
5. Waste products and undeveloped resources.

The interests here treated are thus classified:

1. Primary or exploitative industries (as Agriculture, Mining or the Fisheries.)
2. Secondary or elaborative industries (as the Textile industries, the Ceramic Industries).
3. Auxiliary industries (as Transportation).
4. Technical professions (as Engineering, War, Medicine, Engraving).

The final product of one industry (primary or secondary) may become a material or tool in another art industry or handicraft.

2. Technological Museums come into contact with others, as follows:

With the natural history museum in respect to primary materials.

With the anthropological museum in the matter of tools and processes, especially if historical and retrospective collections are undertaken.

With the art museum in regard to certain products in which a high degree of æsthetic merit has been attained.

With the commercial museum in respect to all products and materials used in commerce and manufactures.

3. There is no such thing in existence today as a general Technological Museum, conducted upon a liberal plan and doing useful educational work. The possibility of establishing such a museum remains to be demonstrated. Attempts have been made at the close of various international exhibitions, but without success.

4. It is possible that experience may show that museum work in this field can best be done in connection with Museums of Natural History and Anthropology, organizing sections of economic zoölogy in connection with zoölogical museums, economic geology and botany, respectively, with the botanical and geological collections. In this way, at least, the natural products and the crude materials could be disposed of to advantage, and the manufactured products, tools and processes, on the other hand, could be shown by the Museums of Anthropology and Art, and in connection with the Mechanical or Patent Museums; though after all a factory in actual operation is the best place to study most modern industries.

[The constantly changing interests of commerce, dependent upon changing fashions and the caprice of markets, might safely be left to the Exposition and Fair, or, if need be, cared for by commercial organizations. In the City of Philadelphia, for instance, there is a most useful permanent exhibition of objects and materials used in the construction and ornamentation of houses, kept up by the 'Building Trades Association.']

F. Commercial Museums.

1. The Commercial Museum has to do with salable crude material and manufactured articles; with markets, means of commercial distribution, prices and the demand and supply of trade.

2. It may properly be connected with the Technological Museum, but for the fact

that its purposes are likely to be more akin to those of the exposition or fair, involving a frequent renewal of exhibits in connection with commercial changes, and often certain features of competitive advertising or display on the part of private exhibitors.

3. The function of this class of museums is two-fold:

- a. To exhibit to home producers the character and location of foreign markets.
- b. To exhibit to foreign buyers the location and products of the home producer.

4. Although the usefulness of the commercial museum has not yet been fully demonstrated, it is conceivable that it might be of great service, could it be made the medium of wide international communication, and the means of a comprehensive system of exchange, through which the collections should be kept up to date and indicate the condition of the various markets of the world.

Essential to the success of such a museum would probably be a bureau of information, through which practical knowledge concerning prices, shipment and the quality of products might be obtained by manufacturers and other interested persons, and samples distributed for use in experiment and comparison.

[Examples of Commercial Museums may be found in the Musée de Melle at Ghent; that of the Chamber of Commerce at Liège, founded in 1888, and the Ottoman Commercial Museum, established in 1890 at Constantinople. These are too recent, however, to afford many lessons.]

G. National Museums.

1. National Museums contain the treasures belonging to national governments and are the legitimate successors of those treasure-houses of monarchs, princes, and ecclesiastical establishments which, until within the last two centuries, were the sole representatives of the museum idea. Every great nation now has a museum, or a group of museums more or less liberally supported,

and intimately connected with the educational undertakings of the government; often, when there are several great cities under one government, each has its own system of museums, and these together form the national system.

2. In most countries of Continental Europe the collections of the national universities form a part of the national museum system and are exceedingly efficient when thus administered.

3. National museums have opportunities which are not often shared by those under state control and their responsibilities are correspondingly great. They should occupy especially those fields which are not provided for in the other museums of the country in which they exist, and should not only refrain from competition with these museums, but afford to them unreserved coöperation.

[The principal purpose of a National Museum must be, as Prof. Jevons has well said, "the advancement of knowledge, and the preservation of specimens of works of art which hand down the history of the nation and the world." In other words, to serve as museums of record and research. It is by no means impossible, however, for them to render excellent service as educational museums, and quite independent of other considerations, they can rarely afford to sacrifice the material advantages gained from the display of popular exhibition series.

A serious obstacle to success in this direction is the vast amount of material which they all possess, and the lack of space in which to admit it. This difficulty may be partly overcome by a liberal assignment of objects to that portion of the study series which is not on exhibition.

A National Museum may not, it is true, advantageously attempt to install its separate departments in such manner as to produce the unity of effect possible in small specialized museums. This, however, is due to the fact that they are obliged to classify their material more strictly, for the attractiveness of a specialized museum grows largely from the fact that many illustrative objects are introduced into the exhibition series which are not strictly in place. The ex-

treme attractiveness of fishery exhibitions, for instance, grows from the fact that so many interesting objects only incidentally connected with the fisheries may be introduced as a setting for the objects directly related to the fisheries.

A result of the same kind is obtained in the Museum of Practical Geology in London, where a selected series of products of all the arts deriving their material from the mineral kingdom—glass, pottery, gems, metal work and many similar groups—are brought in, legitimately increasing the attractiveness of the museum to the visitor and its instructiveness to the student.

Though the great general museum cannot vie in this respect with the local museum, it has a certain advantage of another kind in its very wealth of material, for the display of vast collections, assembled from all parts of the earth and covering, it may be, many acres of floor space, strictly classified and arranged so as to show mutual relationships, affords in itself the most impressive lesson. While in smaller museums the study of individual objects may be easier, in those of the other kind there is a better opportunity for the study of great general relationships.]

H. Local, Provincial or City Museums.

1. To museums of this class belongs the duty of preserving all that which is characteristic of the region or city in which they are located. Every State or Province should have an institution of this kind to care for material illustrating its own geology, zoölogy, botany and archæology. Every city should have a historical collection for memorials of events in its history and that of its representative men.

2. It is legitimate and desirable that Local and Municipal Museums should also enter upon general museum work of a scientific and educational character. They may form collections of a general character, in order that their visitors may see and study the unfamiliar products of foreign lands, as well as those of local interest. In museums of this class, models, casts, copies and pictures of objects not actually obtainable may properly be used.

3. It is often advantageous, in small communities, for the museum and public library to be combined under one roof and one management.

I. College and School Museums.

1. Museums of this class are intended for the use of teachers in connection with their class-room and laboratory instruction, and to reinforce the library in the no-less-important work which it performs for the student.

2. It need scarcely be said that it is impracticable for the smaller teaching museums connected with schools and colleges to carry out the thorough specialization which is attainable in large institutions. A small collection, however scanty and imperfect it may be, is of great value not only for study purposes in connection with some school or college and for exhibition to the local public of a small town, but also as a nucleus for future development.

3. The college or school museum often becomes the local or city museum for the locality in which it is situated, and what has been said about museums of the latter class then becomes applicable to the college museum.

J. Professional or Class Museums.

1. Professional museums are those formed specially for the use of groups of specialists and for the education of specialists. Here belong medical, surgical and pathological museums; military and naval museums; mechanical museums (such as those connected with patent offices and the Conservatory of Arts and Manufactures in Paris); museums for special arts (like the Textile Museum connected with the Gobelin establishment, the Museum of Porcelains, in Sèvres, the Museum of Mosaics in Florence), and certain scientific museums like that of the Geological Survey of Great Britain—the Museum of Practical Geology—the Museo Psicologico in Florence, founded by Mantegazza, and many others.

2. Such institutions, usually under the control of a society, school or specialized bureau, although they may allow inspection by the public, do not necessarily undertake general educational work, but may with propriety consult first, in all matters relating to administration and display, the interests of the class for which they are formed.

K. Private Museums or Cabinets.

1. Such collections undertake work in only one portion of the museum field, that of fostering scientific and historical studies, and so long as they are fruitful in this direction, the manner in which they are administered concerns only the persons by whom they are controlled. It is well that there should be many museums of this kind, and that those who work in them should not be encouraged to dissipate their energies in attempting to do too much of the work which belongs to institutions of other classes, and for which these should be held responsible. These are, to all intents and purposes, scientific laboratories.

2. The private collector is of the greatest service to the public museum. He can, by the use of private wealth or individual freedom, do many things which the officers of a public museum cannot.

3. Private collectors should be encouraged for educational reasons also, for it has been frequently remarked that the men who have had in youth the training afforded by forming a collection have derived therefrom great advantage over others, even though they subsequently pursued commerce or the learned professions.

4. The private cabinet is the school in which the museum administrator forms the tastes and receives the preliminary training which fits him for his profession. There is much truth in the remark of Jevons that the best museum is that which a person forms for himself. If everyone could do this there would be less need for public

museums, but since they cannot, the person who has formed a private collection can most successfully manage one for the use of the public, since he better than anyone else is able, in considering the needs of the museum visitor, to keep in mind that saying which is so useful a guide in museum practice—'Put yourself in his place.'

G. BROWN GOODE.

THE X-RAYS.

HELMHOLTZ, Hertz and Kundt, the three greatest physicists of modern Germany, have died within two years, and the friends of German science feared that this loss would be followed by a standstill in physics, or at least by a lack of really important discoveries. But now we have Professor W. Röntgen's investigations in the physical laboratory of the University in Würzburg, the importance of which does not stand behind the famous electrical discoveries of Hertz in Bonn. Röntgen has found a new kind of rays—he calls them the X-rays—which, though invisible to the eye, affect the photographic plate; which produce fluorescent phenomena; which pass through wood, metal and the human body; which are neither broken by prism and lenses nor reflected.

The chief facts about the X-rays are the following: It is well known that the discharges of a large Ruhmkorff induction coil produce in a vacuum tube, such as Crookes' or Hittorf's, colored rays which go in straight lines from the cathode to the glass of the tube. These cathode rays, which have been much studied, are visible to the eye and are well characterized by the fact that the magnet changes their direction; they do not pass thick cardboard, wood, etc. The place where these cathode rays reach the glass of the tube is the centre of Röntgen's X-rays. They are not visible and are not turned aside by a magnet; in short, they are not

cathode rays, but are produced by them. If in a dark room we cover the tube by thin, black cardboard, nothing can be seen at all, even if we bring the eye in the direct neighborhood of the tube during the electric discharges. But if we now bring a card covered with barium platinocyanide near it the paper flashes up with every discharge, and this fluorescent effect is visible even if the paper is distant 2 meters from the tube, and it does not matter whether the varnished or the other side of the paper is directed towards the tube. The X-rays thus go through the black cardboard which is opaque to sunlight, and the same effect follows when a bound volume of a thousand printed pages is put between the tube and the fluorescent paper. We can measure the perviousness of the different substances to the new rays by the intensity of the light on the paper, comparing the effect with and without objects between the tube and the fluorescent surface. But there is also an objective way possible to study the perviousness, as the rays produce an effect upon photographic dry plates, which, of course, remains and allows us to control the subjective comparisons. Both methods show that wood is not much less pervious than paper; boards 3 cm. thick absorb very little. Hard rubber disks several centimeters thick do not stop the rays, and even aluminium plates 15 mm. thick do not make the fluorescence entirely disappear. Glass plates vary with the lead in them, those containing lead being less pervious. Platinum is slightly pervious, if the plate is not thicker than 0.2 mm., silver and copper can be a little thicker; lead plates 1.5 mm. thick are no longer pervious. All substances become less pervious with increasing thickness, a fact which is nicely demonstrated by photographs taken through tinfoils of gradually increasing number. The perviousness of substances of equal thickness seems chiefly dependent on the density, but

special experiments showed that different metals are not equally pervious if the product of thickness and density is equal; the perviousness of platinum 0.018 mm. thick and a density of 2.15 equals that of lead 0.05 mm. thick, density 11.3 and that of tin 0.1 mm. thick, density 7.1, and that of aluminium 3.5 mm. thick and a density of 2.6. Aluminium may thus be 200 times thicker than platinum, while its density is one-tenth.

The fluorescent effect of the new rays is not confined to barium platinocyanide, but it occurs also on glass, calc-spar, rock-salt, etc. Prisms and lenses do not diffract the rays, nor do prisms of hard rubber or aluminium. With regard to reflection and diffraction the following experiment is interesting. It is well known that pulverized substances do not let pass much light owing to refraction and reflection. Röntgen found with pulverized salt, calc-spar, zinc and other substance that the ray pass through the powder with exactly the same intensity as through the solid substance. Objects with rough surface let it pass exactly like polished ones. The shadow of a round stick is in the middle darker than at the edges; the shadow of a metal tube is in the middle lighter than at the edges.

With regard to the effect on photographic plates, it must not be forgotten that lenses do not refract the rays and therefore ordinary photography is not possible; the pictures of the objects are only shadows. But these shadow-pictures can be taken in the closed wooden box of the camera in a light room, as the sunlight of course does not pass through the wood while the X-rays do. In this way Röntgen took photographs of a set of metal weights in a wooden box and of a thick wire wound as a spiral around a wooden stick; the wood was pervious, the metal of that thickness not, and so the shadows of the weights and of the wire are seen in the photograph, those

of the wood scarcely at all. In the same manner he took the picture of a compass needle in the closed box. The door between two rooms did not hinder the chemical effect.

With regard to the nature of the X-rays it seems too early to say anything definite. Röntgen emphasises the fact that they show no refraction and probably therefore move in all substances with equal velocity and are transmitted by a medium which exists everywhere and in which are the molecules of the substances. That is they are ether rays, but not transverse ether waves like the visible or the ultra red or ultra violet invisible light; Röntgen supposes that they are longitudinal ether waves, the existence of which has for a long time been suspected by physicists. Researches regarding many other qualities of the new rays are in progress, and their results may clear up the theoretical interpretation.

It may be that the practical importance of the discovery is equal to the theoretical. It is well known throughout the world that the physical laboratories of Germany have no windows looking towards the patent office. The hunting for practical inventions is not usually important for theoretical science, but the progress of theory usually has practical applications. One practical result in this case is already clear, as the new rays pass boards but not thick metal plates, so they pass the organic substances of the human body, such as skin, muscles, etc., but not the bones. As the metal weights in the wooden box can be photographed, so can photographs of the human bones be taken. Röntgen has put his hand between the tube and the dry plate in the closed camera; the photograph shows clearly all the bones of the hand without the flesh and skin, and the gold rings seem to hang in the air. The value of such a method for medical diagnosis is clear. Fractures and diseases of bones can be examined by

photographic plates and metal pieces in the body, for example, needles, bullets, etc., can be found by this method. It will be a matter of the future to learn whether the rays have psycho-physiological effects.

The newspapers report that the whole thing was discovered by mere chance. Röntgen saw the effects on photographic papers which by chance were near to a covered tube during the discharge. This chance origin is not probable, as Lenard, the assistant of Hertz, has been working in the same direction for a long time, and many preparatory experiments by Röntgen himself cleared slowly the way. But suppose chance helped. There were many galvanic effects in the world before Galvani saw by chance the contraction of a frog's leg on an iron gate. The world is always full of such chances, and only the Galvanis and Röntgens are few.

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FREIBURG, BADEN, January 15, 1896.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR RÖNTGEN'S DISCOVERY.

THE transmission through wood and other substances of the rays from a Crookes' vacuum tube, discovered by Prof. Röntgen, is reported to have been confirmed by Prof. Klupathy of Pesth, Prof. Domalip of Prague, Prof. Czermak of Gratz, and Mr. A. A. C. Swinton of London. The photographs have been exhibited before several scientific societies and by Prof. Röntgen to the Emperor of Germany, from whom he has received a decoration.

Mr. Swinton writes to the *Standard* that with Mr. J. C. M. Stanton he has obtained distinct proof that the radiations in question do pass easily through various substances that are quite opaque to ordinary light, and do produce strong impressions upon ordinary photographic plates entirely incased in light-proof material. Indeed, all substances that he has so far experimented on in his laboratory appear to be transparent to these radiations, even sheets of ebonite, carbon, vulcanized fibre, cop-

per, aluminium and iron, though there is considerable variation in degree. It is thought that the new method of photography may have important applications, not only in surgery, but also in metallurgy, by revealing flaws, inequalities and fractures in metals.

Hertz discovered that cathode rays pass through metal films not translucent to ordinary light, and that Dr. Lenard and others have published careful experiments on the subject. Attention has been called to Prof. Zeugen's having photographed Mt. Blanc, in 1885, by the cathode rays. Prof. Röntgen, however, states that the rays discovered by him, which he calls X-rays, are not cathode rays, as they are not refrangible nor affected by magnetic influences, but that they are more probably longitudinal waves in the ether.

While Hertz and Lenard hold that the cathode rays are vibrations in the ether or even light of short wave-length, Crookes and J. J. Thomson have urged that the rays are negatively charged matter traveling with great velocity. M. Perin reported to the Paris Academy, on December 30th, experiments which tend to show that the latter view is correct, and some relation will probably be found between cathode rays and the X-rays.

PHYSICS.

By constructing what might be termed a reversed level, A. Toepler obtains an instrument which he calls a 'pressure level.' It consists of a tube bent to a slight angle at its middle point; the two ends are equally inclined to the horizontal. A short column of a light liquid fills the central portion of the tube. It will be readily seen that if the two open ends are connected with two receivers of any sort, the liquid will, by its position, give the difference of pressure in them. This method of differentially measuring pressures, Mr. Toepler applies (*Wied. Ann.*, Vol. 56, 1895) to measure the difference in weight of two columns of air at different temperatures but both under the same pressure. A long series of determinations of absolute temperatures bears witness to the efficacy of this method, and theoretical considerations remove some apparent objections and give to it certain advantages over the ordinary form of air thermometer.

THE old question as to the existence of Volta's 'contact electricity' is again taken up by C. Christiansen (*Wied. Ann.*, 56, 1895.) who, with an apparatus employing the drop electrode, has investigated the behavior of magnesium, aluminum, cadmium, zinc, tin, lead, iron, platinum, nickel, copper, mercury and carbon in atmospheric air, hydrogen, carbonic acid gas and oxygen, and arrives at the conclusion that oxygen may be, if it is not always, the cause of potential differences between metals in contact, and he is of the opinion that it is a polarization by the gas, just as oxygen or hydrogen polarizes platinum.

G. Meyer investigated an allied subject with the Lipmann capillary electrometer testing the combinations of mercury, and lead, copper, tin and zinc amalgams in sulphuric and hydrochloric acids, potassium chloride, iodide and sulphocyanide, and sodium sulphide. A further contribution to our knowledge of the dielectric constant is made by S. Silberstein, who has determined this constant for various mixtures of benzol and phenylethylacetate, and finds that the results agree well with the conclusions derived from theoretical considerations. (*Wied. Ann.* Vol. 56, 1895.)

W. H.

ASTRONOMY.

THE Astronomical Society of the Pacific has just published an account by Prof. Tucker, of the methods he is using for the investigation of the division errors of the Repsold circle of the Lick Observatory. We are glad to see the principle of using the auxiliary circle for the purpose of investigating the principal circle. This plan has many advantages, but its weak point of course is that the two circles are at some distance from each other and are read by different microscopes. It may not be generally known that a transit circle was constructed by Messrs. Cooke & Sons for Mr. Newall, under the superintendence of Mr. Marth, in which the divisions of the two circles could be brought into the field of view of one microscope simultaneously. The errors of that circle, however, were never investigated.

But it may be questioned whether the results ever justify the expenditure of the great amount of time and labor involved in such in-

vestigations as that of Prof. Tucker. Probably the same amount of energy given to observation of the stars, taking care of course to shift the circle from time to time, would be of greater benefit to astronomical science. Even if the division error of any given line could be determined with complete precision with the telescope pointed at the zenith, this division error would not hold true when the telescope is directed elsewhere. Nor is this brought about by flexure alone. It is found that if we determine the division errors of a straight scale, these errors are completely changed when the scale is reversed end for end. No doubt unavoidable differences in the illumination and the eye of the observer are responsible for these unfortunate facts. But facts they are, and the cause of much wasted labor.

THE 1890 volume of the *Annuaire* published by the Bureau des Longitudes has been issued. It contains the usual mass of material devoted to astronomical and other science. Among the appendices are articles by MM. Cornu and Janssen, which are of general interest. The list of members of the Bureau contains the names of two Americans: Dr. B. A. Gould and Mr. G. Davidson. The latter gentleman is described as 'directeur de l'observatoire de Californie et du Service geodesique.'

H. J.

GENERAL.

THE herbarium of the late Prof. Daniel Cady Eaton has been presented by his family to Yale University. The herbarium contains over 65,000 sheets, and is especially rich in North American ferns and mosses.

THE library of the University of Pennsylvania has acquired the scientific library of the late Prof. John A. Ryder. It has also secured the Bechstein Library of German Philology and Literature, containing about 20,000 bound volumes and pamphlets.

Nature states that Prof. Sollas, F. R. S., will leave in March for Sydney, to take charge of an expedition that is being dispatched to make deep borings in a coral atoll. The scheme, which is supported by a strong scientific committee, has been financed by the Royal Society to the extent of £800; and the government are placing a gunboat at the disposal of the party, to convey

them from Sydney to Funifuti, in the Central Pacific, which has been selected as the scene of operations. Mr. W. W. Watts writes to the same journal that it would have been impossible to undertake the work without the assistance of the Departments of Mines of the New South Wales government, which has granted to the committee a complete set of boring tubes and appliances.

THE Field Columbian Museum, of Chicago, will send a commission, including Professor D. G. Elliot, one of the curators, and Mr. C. A. Aikley, the taxidermist of the Museum, to Central Africa to collect zoölogical specimens. It is proposed to leave Chicago about March 1st, and to spend six months in Africa.

THE New York section of the American branch of the Society for Psychical Research will have its next meeting at Columbia College, on February 1st, at eight P. M. Prof. William James will preside and will make an address. Papers will be read by Prof. J. H. Hyslop on 'Experiments in Crystal Vision,' and by Prof. W. R. Newbold on 'Three Cases of Subconscious Reasoning.' A meeting will be held in Boston, at Allston Hall, on the preceding evening.

AT the annual meeting of the Anthropological Society of Washington, held January 21st, Prof. Lester F. Ward was elected President for the ensuing year; Surgeon General George M. Sternberg, Dr. Frank Baker, Mr. W. J. McGee, and Mr. George R. Stetson, Vice-Presidents; Dr. J. H. McCormick, General Secretary; Mr. Weston Flint, Secretary to the Board of Managers; Mr. Perry B. Pierce, Treasurer; and Mr. F. W. Hodge, Curator. Dr. Cyrus Adler, Mr. Joseph D. McGuire, Mr. James A. Blodgett, Dr. Washington Matthews, Dr. Thomas Wilson, and Prof. J. Ormond Wilson were elected Councilors. Dr. Robert Fletcher, Prof. Otis T. Mason, and Major J. W. Powell, former presidents of the Society, are *ex-officio* members of the Council.

AT the annual meeting of the Royal Meteorological Society, on January 15th, Mr. E. Mawley was elected President, and the retiring President, M. R. Inwards, delivered an address on Meteorological Observatories.

THE third course of annual lectures of the Linnæan Society, in connection with the American Museum of Natural History, is as follows:

January 14, 1896. *The Indians of Vancouver Island*. By Dr. Franz Boas, American Museum of Natural History.

January 18th. *The Origin and Distribution of North American Mammals*. By Prof. W. B. Scott, Princeton College.

March 3d. *Two Months in Greenland*. By Prof. William Libbey, Princeton College.

MR. C. E. BORCHGREVINK has sent his mineralogical collection from South Victoria Continent to Dr. John Murray, F. R. S. Mr. Borchgrevink holds that his specimens are especially valuable as proving the existence of an Antarctic continent.

THE cost of sending an expedition from the Lick Observatory to Japan to observe the approaching eclipse of the sun will be defrayed by Mr. C. F. Crocker, of San Francisco.

A CABLEGRAM to the daily papers states that Dr. Behring has discovered an anti-cholera serum, and announces that a public demonstration of its properties will be made at an early date.

WE learn from *La Nature* that the Venetian Society for the encouragement of pisciculture has secured, from the Aquarium of the Trocadero at Paris, spawn of the California salmon, to be placed in the streams of the province.

Nature states that Mr. John Donnell Smith is still in Nicaragua, in pursuance of his botanical explorations, which have already been so fertile in additions to the Central American flora, and that M. R. Schlechter is intending shortly to start on a two years' botanical exploration of the south and east of Africa. His program includes a prolonged stay in Namaland, the Transvaal, Coud-Bockeveld, Limpopo and Matabeleland as far as the Zambesi. Subscriptions for his collection will be received by Prof. Schumann, Botanical Museum, Grünewald str., Berlin. They will be at the rate of 35 marks the hundred.

LIEUT. E. ASTRUP, the Arctic explorer who was with Lieut. Peary on his first expedition to Greenland, was found dead on Jan. 19th in a valley in the Dovrefjeld Mountains, near Jer-

kin, Norway. He started from Christiania before Christmas to make an exploring trip on skis in the mountains. He had apparently been overcome by fatigue and cold. Lieut. Astrup was only 31 years of age.

At a general meeting of the London Institution of Electrical Engineers, on January 16th, Mr. Crompton, the retiring President, gave up the chair to Dr. John Hopkinson, who delivered his inaugural address, reviewing at length the progress which had been made in the direction of practical applications of electrical knowledge during the past sixty years.

WE have received the first bulletin of the *Institut International de Bibliographie*, which will hereafter be published from the office of the Institute, 11 Rue Ravenstein, Brussels. It contains the address of Chev. Descamps given at the close of the recent International Congress of Bibliography, the rules of the Institute, the plans proposed for a general bibliography by MM. H. La Fontaine and P. Otlet, and notes on the decimal system of classification.

THE *Engineer* has offered a prize of a thousand guineas for a contest of horseless carriages to take place in England in October, and arrangements are being made by American manufacturers for a similar contest between Jersey City and Philadelphia with a prize of \$5,000, to take place as soon as the roads are in good condition in the spring.

ARRANGEMENTS have been made for the following lectures to be given before the Royal Institution before Easter: Dr. J. G. McKendrick, professor of physiology in the University of Glasgow, six lectures on 'Sound, Hearing and Speech'; Prof. Charles Stewart, Fullerton professor of physiology, R.I., eleven lectures on the 'External Covering of Plants and Animals: its Structure and Functions'; Mr. H. Marshall Ward, Professor of Botany in the University of Cambridge, three lectures on 'Some Aspects of Modern Botany'; Lord Rayleigh, professor of natural philosophy in the Royal Institution, six lectures on 'Light.' The Friday evening meetings will begin on January 17th, when a discourse will be given by Lord Rayleigh on 'More about Argon.' Succeding discourses will probably be given by Prof. Bur-

don Sanderson, Dr. John Murray, Dr. Edward Frankland, Prof. T. R. Fraser, Prof. Dewar and other gentlemen.

ACCORDING to the *Lancet* the trustees of the Bellahouston fund have made the following additional bequests to Glasgow Infirmary: 1. To the Royal Infirmary (1) a grant of £2,500 in supplement of an equal sum already paid by the trustees for the better equipment of the medical school; and (2) a grant of £7,500 towards the erection of a pathological museum and laboratory and another operating theatre, to be called the 'Bellahouston theatre.' 2. To the Western Infirmary (1) a grant of £3,500 for the erection of another operating theatre, to be called the 'Bellahouston theatre'; and (2) a grant of £5,000 towards the erection of pathological buildings. 3. To the Victoria Infirmary a grant of £6,000 for the erection and equipment of a dispensary for out-patients, to be called the 'Bellahouston dispensary.'

THE annual loss to Pennsylvania by forest fires is estimated by the State Forestry Commissioner to be at least \$1,000,000. He holds that the fires are always due to ignorance, carelessness or crime, and that these may be controlled.

THE multiplication of laboratories for the study of experimental psychology has nearly ceased, only because almost every school of any importance now possesses such a laboratory. It is already evident that a second era in this movement is beginning. A few weeks ago it was announced that the department of psychology at Cornell University had just taken possession of splendid new quarters on the fourth floor of Morrill Hall, comprising a series of nine rooms and some 4000 feet of floor space. Word now comes from Nebraska that psychology has just moved into the first floor of the new library building and occupies a series of five rooms with a floor space of about 3000 square feet. The rooms comprise a lecture room that will accommodate one hundred students; a study that may be used also as a private laboratory; a shop equipped with lathe and tools, to the value of about \$300 (this room is also used as laboratory at certain hours); and two large rooms for general laboratory practice, one of which has a small dark room cut off.

The building is by far the best constructed, not only of the University buildings, but of all the State buildings. The first floor is finished in hard pine, with two-inch hard maple floor laid in cement. One of the laboratory rooms is provided with three stone piers, extending directly into the ground with tops 20x24 inches. This same room has six windows, each $7\frac{1}{2} \times 4\frac{1}{2}$ feet. Double shades, white and black, regulate the light. One hundred and fifteen students are now taking work in psychology in the University of Nebraska.

UNIVERSITY AND EDUCATIONAL NEWS.

GROUND has been broken for the first of the four buildings of the new biological school of the University of Chicago, which is to be erected with part of the \$1,000,000 recently given by Miss Culver. It is proposed to erect special buildings for zoölogy, botany, anatomy and physiology, instead of one biological building, as planned before the receipt of Miss Culver's gift.

THE College of New Jersey, Princeton, will celebrate the 150th anniversary of its foundation in October next. It is proposed to hold an academic festival on October 20, 21 and 22, at which time it is said the name of the institution will be altered to Princeton University. An effort will be made to largely increase the endowment of the College, the money to be used chiefly in developing the University work.

ELIZA M. MOSHER, M. D., of Brooklyn, N. Y., has been appointed a professor of hygiene in the University of Michigan.

THE Fellows of the Royal College of Surgeons, London, on January 2, declared themselves, by a vote of 72 to 10, in favor of admitting women to the examinations and diplomas of the College.

VASSAR College has received \$8,000 from Miss Helen Gould for the foundation of a scholarship.

THE Senate of Toronto University has made a claim against the Province of Ontario, or the Dominion of Canada, for more than \$100,000.

THE University of Pennsylvania has received a gift of \$5,000 from Mr. Charles M. Swain and \$5,000 anonymously, the money to be used without restrictions.

THE will of the late Martin Brimmer, of Boston, to take effect on the death of his wife, bequeaths \$50,000 to Harvard University.

DISCUSSION AND CORRESPONDENCE.

THE METRIC SYSTEM.

EDITOR OF SCIENCE: I enclose a copy of House Bill No. 2758 in regard to the Metric System. This bill has been introduced by Hon. D. Harley, of Brooklyn, N. Y., after consultation with the Secretary of the American Metrological Society and officers of the U. S. Government (Gen. Duffield, Superintendent of U. S. Coast and Geodetic Survey; Professor Newcomb, of the Nautical Almanac Office, and Mr. Tittmann, of the Coast and Geodetic Survey), and others. The Committee on Coinage, Weights and Measures, of the House of Representatives, has the bill in charge. Hon. C. W. Stone is Chairman of the Committee.

It is hoped that those interested in the matter will urge on the Committee the great desirableness of a favorable report to the House.

J. K. REES.

AMERICAN METROLOGICAL SOCIETY,

OFFICE OF SECRETARY,

NEW YORK, January 24, 1896.

The bill to fix the standard of weights and measures by the adoption of the metric system of weights and measures is as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first day of July, eighteen hundred and ninety-seven, all the Departments of the Government of the United States, in transaction of all business requiring the use of weight and measurement, shall employ and use only the weights and measures of the metric system, as legalized by Act of Congress approved July twenty-eighth, eighteen hundred and sixty-six.

"SEC. 2. That from and after the first day of July, eighteen hundred and ninety-nine, the metric system of weights and measures shall be the only legal system of weights and measures recognized in the United States.

"SEC. 3. That the tables in the schedules annexed to the bill authorizing the use of the metric system of weights and measures, passed

July twenty-eighth, eighteen hundred and sixty-six, shall be the tables of equivalents which may be lawfully used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system."

IMPROVED BLACKBOARD.

EDITOR OF SCIENCE: Several persons have enquired about the blackboard mentioned in your columns recently. May I describe it briefly: A sheet of ground glass a meter square is framed and the frame is hinged into a very shallow cupboard fastened to the wall. A false bottom covered with padded serge fits this cupboard loosely, and when the door is closed and fastened presses firmly against the glass on the inside. It then forms a fine blackboard as the ground glass surface is perfect for use with crayons.

If the door be opened and a sheet of white paper fastened to the false bottom by thumb tacks, it becomes an equally useful drawing slate for colored crayons. If in the place of the white paper a sheet of drawings as of crystal forms or geometrical figures, or outline maps be put behind the glass they show through so that all modifications of the primary form beneath can be drawn on the glass and in proper relation to this primary. It is only needful that the false bottom shall press firmly against the glass, and this is easily effected by having it held in place by four screws placed near the corners whose heads are countersunk in the false bottom. The latter moves freely on these screws and four spiral springs which are slid on the screws behind it press the serge firmly against the glass.

BEN. K. EMERSON.

AMHERST, MASS., January 14, 1896.

SCIENTIFIC LITERATURE.

Elementary Physical Geography. By RALPH S. TARR. 12 mo., pp. 1-xxxl., 1-488, 29 plates and charts, 267 diagrams and photographs. Macmillan & Co. 1895. Price \$1.40.

Physical geography is no longer a mere description of the earth's surface, but includes also an enquiry as to how its features came to be what they are. The recent ideas that have vivified this study and placed it on a scientific

basis may be seen by contrasting the writings of Ritter, Humboldt, Guyot and others of what may in all courtesy be termed the old school, with the book before us. In the older books, which are by many persons still considered fountains of geographical knowledge, the leading theme is the description of the earth; in Tarr's physical geography the dominant idea is how the features of the earth came to have their present characteristics.

In descriptive physical geography the continents are sometimes treated as fragments of broken china, which, by the exercise of much ingenuity and an active imagination, are made to fit together with more or less accuracy, thus leading the student to fancy that at one time they were united. In rational physical geography each continent is shown to have a life history, and to have been modified by elevation and subsidence, and varied in relief by erosion and sedimentation. In the modern view of nature even the largest of land masses are found to be unstable forms; the processes to which they owe their elevation above the sea, as well as their outlines and relief, are still active, and additional changes are to come. Mountains are no longer to be studied as finished forms, but as representing all stages of growth, adolescence, maturity and old age. River valleys are not merely drainage canals, the lengths and breadths of which are to be memorized, but each one has a history written in its terraces and flood plains, in which evidences of elevation and depression of the land, climatic changes, the influence of rock structure, etc., can be read.

The modern ideas referred to, which, so to speak, have blown away the mist from the landscape and revealed its varied beauties, are truthfully reflected in the book before us. One who is familiar with the progress of geological study in America sees, as he turns its pages, an epitome of the results brought by many conscientious workers from the mountains and valleys, with much labor and thought. Most of all, it is flavored with the studies of Prof. Davis, of Harvard, in whose class room and from whose writings Prof. Tarr has gained much of his inspiration. The great sources both of facts and ideas, as must of necessity be the case in

all attempts to write the physical history of North America, with which the book is mainly concerned, are the reports of the geological surveys of Canada, the United States, and of many individual States. The results of these great surveys reach the people and the schoolroom directly, to only a comparatively limited extent; probably their greatest popular usefulness lies in the fact that they are mines of wealth to those who attempt to popularize and disseminate scientific knowledge.

Physical geography is treated by Prof. Tarr under three leading topics: *The Air, The Ocean, The Land*.

The Air: The part treating of the air begins with an account of the relations of the earth to other members of the solar system and is in fact an introduction to the entire subject of physical geography. This chapter probably differs less than any other portion of the book from older treatises on the same subject. Necessarily the subject-matter to a great extent is borrowed from astronomy.

The discussion of atmospheric temperatures, moisture, condensation, clouds, etc., the nature and origin of storms, distribution and characteristics of climate and other similar phenomena, brings out the results of the most recent studies in this important branch of the subject. To a great extent these chapters are a compend of Davis' *Meteorology*, a book that should be at hand when instruction in this portion of the subject is given.

The Ocean: In dealing with the geography of the sea, the rich store of knowledge resulting from the Challenger, and other similar expeditions, furnishes the data for presenting a comprehensive outline of the results of recent surveys. Some of the subdivisions of the subject as treated are: methods of deep-sea explorations; topography of the sea bottom and of coast lines; deposits now forming on the sea floor; temperatures; chemical composition, circulation, etc., of sea waters; general distribution of life in the sea; the causes of currents and tides; and the effect of the movements of sea water are discussed and illustrated by diagrams, maps and photographs.

The Land: It is in this portion of the book that the greatest advances, both in geography

as a science and in methods of study, are shown. The processes by which the rocks forming the land are disintegrated and carried away are discussed and the resulting changes in topography clearly described. The fact that all rocks which rise above sea level are constantly yielding to chemical and mechanical agencies and being removed by streams in solution and suspension leads to the recognition of a fundamental principle, first definitely stated by Major Powell, which is of wide application in both geography and geology. This tendency to reduce all land areas to the level of the sea, or to *baselevel*, as it is termed, if not counteracted by movements of elevation, will result in the production of plains. Such plains of subaerial denudation, or *peneplains*, are a characteristic feature of many regions.

A knowledge of the way in which streams deepen and broaden their valleys, and slowly adjust themselves to rock structure, gives meaning to a multitude of geographic forms, that would otherwise appeal to the eye alone without awakening a mental picture of the long series of changes of which they are the result.

The deposition of the waste of the land in flood plains and deltas, and its distribution over the bottoms of lakes and on the ocean's floor, illustrates other phases of the never-ending changes that attract the eye of the geographer. These wide reaching processes and the character of the results they produce are tersely outlined.

The characteristics of glaciers and the changes they bring about in the topography of the land, both by erosion and deposition, form a chapter that cannot fail to awaken interest especially in the minds of students whose homes are in the northeastern States or Canada, since not only the general expression but almost every detail in the landscape with which they are familiar is an inheritance from an ice invasion.

The study of coast lines shows that the agencies by which the relief of the surface of the land is modified are supplemented by analogous agencies which are constantly altering the direction and varying the details of the margins of continents and islands.

Many of the results of erosion and deposition are illustrated by home example and supplemented by photographs of American scenery.

The book is emphatically an American book, and especially well adapted for American students.

A chapter is devoted to volcanoes, earthquakes, geysers; another to the general topography of the land. The relations of man to his environment, and the products of the rocks that are of leading economic importance, are also considered as fully as the space available will allow.

An important feature of the book, and one that places it in advance of all other similar treatises, is the free and one might say almost lavish use of photographs. While some of them are so much reduced and so poorly printed that they have lost their beauty, and are even obscure and of little value, yet the preference, in many instances, of photographs over sketches and wood engravings for text-book use is thoroughly demonstrated.

At the close of each chapter there is a short list of books which will aid the teacher in extending the subjects outlined in the text, and enable him to add fresh description and discussions from authoritative sources.

Now that a text-book of rational physical geography, designed for school-room use, is available, which presents the modern aspects of the subject as well, perhaps, as could be done in an elementary treatise, there is no longer an excuse for practically excluding this attractive and stimulating branch of nature study from our schools. It has frequently been stated that it is useless to attempt to teach physical geography in its modern dress, for the reason that properly trained teachers were not available. With Tarr's book in hand and works of reference available, there is no reason why many graduates of normal schools and colleges should not prepare themselves for this work. Without, however, a certain indescribable sympathy with nature, a deep appreciation of the beauties of form and color in a landscape, and a quenchless thirst to know how the numberless features of the land, sea and sky came to be what we find them, one need not expect great success as a teacher of physical geography. Given a love of nature and such a guide-book as Prof. Tarr has compiled, and the path leading to the commanding height from which the

history of the earth's surface can be read as from a printed page may be readily reached.

Necessary adjuncts to a text-book of physical geography, are maps, especially of the region where the teacher is located, large-sized photographs or lantern views, globes, models, etc. These appliances, however, are of comparatively little use, unless, as expressed by Davis, 'the oversight is aided by the insight.'

In closing I wish to say, as has been stated in the report on a recent conference in geography, that the study of physical geography demands an advanced position in both school and college training, for the reason that it develops the power of observation, the powers of scientific imagination, and the power of reasoning.

ISRAEL C. RUSSELL.

The Great Frozen Land: Narrative of a winter journey across the Tundras and a sojourn among the Samoyads. By FREDERICK GEORGE JACKSON. Macmillan & Co., New York. 1895.

In this pleasantly written and by no means over-scientific volume, the leader of the Jackson-Harmsworth Polar Expedition (now passing its second winter in the region of Franz Josef Land) gives the narrative of a long sledge-journey across the frozen lands of northern Russia, from the Yugor Strait to the Varanger Fjord—a journey undertaken primarily with a view of testing certain requirements of travel which might be found necessary in the more arduous Polarctic work for which the author had been preparing. The land-traverse compassed some twenty-five hundred miles across the Great and Little Tundras, and over a solitude, as stated in the prefatory remarks of Mr. Montefiore, 'through which no Englishman had ever passed; of which no sufficient map existed; whose table of river-labyrinths, ancient beaches and lost bays had never been told; of whose winter climate no account was to be discovered in the English tongue.' Just why these deficiencies in English knowledge and energy are so strongly emphasized does not appear clear, and it can, perhaps, hardly be said that Mr. Jackson's travels acquire importance through them alone.

There is much in this book to interest the general reader, and particularly acceptable are

the glimpses of cold nature which we obtain here and there scattered through the pages, and the inner vista into the natural life of those peculiar children of the north, the Samoyads. Mr. Jackson lived with them in cleanliness and dirt, in health and distemper, and behind pony and reindeer, and is, therefore, in a position to give a picture that is neither under-colored nor over-colored. Apart, however, from a general broad description of both people and country there is little in the book to tax the mind of the inquiring scholar, and least that of the scientist. Zoölogical, botanical and geological data are exceedingly meagre, and, owing largely to the loss of the thermometer record-book for the months of December and January, there is little to add to meteorology. The lowest reading of the thermometer was found on December 5th,—36°.5 F. Mr. Arthur Montefiore, the editor of Mr. Jackson's journals, contributes a chapter on the Samoyad language, a series of translations on Samoyad folk-tales from Casttrén's *Ethnologische Vorlesungen*, and an appendix on the 'object, method and equipments' of the Jackson-Harmsworth Polar Expedition.

The tone of the book, both as it is found in the main text and in the contributions of the editor, leads to a lingering suspicion that it is conceived too much in a spirit of enthusiasm to permit it everywhere to be followed as a safe guide. Thus, in the prefatory remarks the reader is led to believe that the journey was undertaken in the region of 'the Pole of Extreme Cold,' but between the minimum thermometric registry that has been above noted (−36°.5 F.) and the cold of Yakutsk and Verkshojansk, minus 75°–82° F. (or, according to report two years ago, −92°), there is a vast difference—the difference, in fact, between Minnesota and what is experienced by almost every Arctic expedition wintering in the far north. We are informed on page 160 that a journey of 700 versts (about 470 miles) was accomplished in seven and a-half days, on two sledges, 'one horse to each sledge,' and that at the end of the journey the horses 'trotted into Pinega apparently as fresh as paint.' To travel sixty miles a day for seven days in succession is certainly no ordinary feat for horses even of the Russian type, and many a carrier would be welcomed

for this undertaking into the camps of the Russian or German military posts; but what dignity or honor would be conferred upon a Zirian who drove three reindeer, within a period of twenty-four hours, over a distance of 1200 versts (800 miles)! It is hardly to be wondered at that the team died on the following day (p. 74).

Almost the only fact of physiographic importance which is noted is the occurrence of raised beaches near the mouth of the Piatso-woryaha River, where the amphitheatre of an old bay extends backward a distance of some nine miles from the present seashore. "Step above step there ranged the old seabeaches, following the lines of the higher land immediately behind them, and girding with a terraced rampart the level basin of salt marsh into which the waves once rolled. * * * * * These old seabeaches, I may add, continued for many miles westward—notably that which is now six miles from the sea, and lies just to the east of the Pechora River—and most certainly would repay the attention of a geologist if he could visit them in summer" (p. 129).

Mr. Jackson is now working in an important field of exploration, and scientists, no less than geographers, cannot but wish him success in an undertaking which requires for its accomplishment a more than ordinary amount of courage and determination, and a knowledge of the kind which must be forced upon every traveler who attempts the long passage of the Great Frozen Land.

ANGELO HEILPRIN.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, January 11, 1896.

A Complete Geography. By ALEX. E. FRYE.
Ginn & Co., Boston, Mass. 1895.

Since the publication, last year, of Frye's *Primary Geography*, the appearance of a larger book for grammar school use, promised by the same author, has been awaited with much interest. This book is now at hand. Its plan, like that of the *Primary Geography*, departs widely from the beaten track followed by most writers of school geographies. This has generally consisted of an introductory chapter on the earth's mathematical features, followed by a condensed review of physical geography, after

which the several continents are successively described in their various aspects, the United States naturally receiving the chief attention, and the physical features of each region being considered in close connection with its political and industrial features. But in the new book the most striking feature is the division of the entire subject into two well-marked fields: the first, which occupies some two-thirds of the book, being devoted to the physical features of the earth, and the rest dealing with political geography.

This plan will commend itself to many. The physical features of the earth are the foundation upon which the history of the nations has been wrought out to its consummation in the political geography of our own day; are, in fact, the mould which has determined the present aspect of political geography. It seems appropriate, therefore, that these relatively permanent physical features should receive primary, and the relatively transient political facts secondary attention, and that a full and clear understanding of these fundamental elements of the earth's surface should give the pupil a sound and thorough basis for all future knowledge which he may acquire, either during or after his school days, about the earth and all that happens thereon.

In accordance with sound pedagogical principles, the broader physical facts are first treated, so that an outline of the subject is built up in the pupil's mind, to be filled in later by more specific details when each region is taken up in its turn. Here it is gratifying to see that the author has kept closely in touch with the most recent scientific studies upon the form and development of the land surface. It is exceptional to find a geography that recognizes so fully the changes in the land surface by wear (Lesson 11), or the rise of the sea floor to become new land (Lesson 18), or the growth and relative age of mountain ranges (Lessons 19, 77, 89), or the work of the North American ice sheet during the glacial epoch (Lesson 45). The appearance also of such current scientific phrases as 'drowned valley,' 'distributary,' 'drumlin,' 'fiord,' 'alluvial fan,' etc., is another mark of the recognition of the labors of modern scientific geographers.

The illustrations and maps, which in any geography are quite as important an educational element as the text itself, are numerous, closely connected with the text, and for the most part carefully executed and well arranged. Most of the pictures are engraved directly from photographs, a sure means of securing truthfulness. The numerous little globe maps will commend themselves for the views that they give of the relations of the continents and oceans. The usefulness of such a map as that on page 102, however, where the earth's crust is as it were peeled off from the hidden side, and bent around so as to bring all the lands into view at once, may be questioned. The curved distortion necessarily resulting is such as to make the earth here appear neither flat nor round. Such features as this map illustrates, are better shown upon Mercator maps, which, of course, are distorted, but in a manner simple and easily understood. The clearness and simplicity of the study maps throughout the book is worthy of mention, as is also the presence of an entirely separate, large collection of reference maps, abounding in detail, at the end of the book.

The book, of course, is not without its defects. The useful system of cross-references contains some misprints, which escaped notice in the final revision; and in the reference-maps we observe the omission of so noted a volcano as Krakatoa, the insertion of the long-since ruined and abandoned Chenango canal (N. Y.), and the failure to distinguish the political boundaries of Russia from the conventional limits of Europe, where the two happen not to coincide. A good index would be a valuable addition.

The meagre and almost purely categorical treatment of many countries in the latter part of the book is also disappointing. Their physical features are well set forth in the first part, and many facts of interest are mentioned in connection therewith; but in the second part, which deals expressly with political and industrial geography, we regret to see Italy dismissed with but ninety-two words, Greece with but nineteen, and the governments, cities, people, customs and industries of many other foreign countries treated with similar inadequacy. But the book already exceeds the size of the average

grammar school geography by more than fifty pages, and the necessary limits to the size of such a book are evident. Such matter might, of course, be supplied by the use of supplementary geographical reading, or by the teacher; but, unfortunately, few schools have the access to good libraries which will make the former possible; and few teachers have a sufficient fund of general information to enable them to supply this need.

To use this book, with all its excellent features, as it should be used to reap the full benefit of its contents, calls for a degree of skill and ability on the part of our teachers beyond that of the average instructor; and school superintendents in places which have adopted it will find it no easy task to educate their teachers to this end. But as the book sets before us a higher standard and ideal of geographical teaching than our schools have ever known before, and as it tends to bring them into closer relations with the best scientific work of the day, it deserves a hearty welcome.

T. W. HARRIS,
Supt. of Schools.

KEENE, N. H.

The Religions of India. By EDWARD W. HOPKINS. Boston, Ginn & Co. 1895. 1 vol., 8vo., pp. 612.

The Teaching of the Vedas; what light does it throw on the Origin and Development of Religion? By MAURICE PHILLIPS. London, 1895. 1 vol. 8vo.

Of these two books, appearing almost simultaneously, the first mentioned is much the more important in scope and scholarship. It is volume I. of the 'Handbooks on the History of Religions,' edited by Dr. Morris Jastrow, Jr., of the University of Pennsylvania, and its author is Professor of Sanscrit in Yale College.

The plan of his work may be briefly stated. He begins with an examination of the date of the oldest Vedas, reaching the conclusion that the bulk of the Rig Veda was composed about a thousand years before the Christian Era. This is a late date to assign it, and we are inclined to believe that the author has been too much influenced by a certain French school who have set themselves to modernize everything ancient by one-sided arguments. A chapter follows

devoted to the ethnography of India, illustrated by a map. The leading questions are touched lightly, dates of monuments are not attempted, and the main points averred are the close relationship of the Vedic Aryans to the Iranians, the entrance of the early hordes through the open pass of Herat, and the existence of castes among them before their settlement in India.

Four chapters are assigned to an exposition of the pantheon of the Rig Veda, and one to the religion of the Atharva Veda, which are followed by a careful and clear comparison (Chap. VIII.) of the early Hindu divinities with those of other Aryan and some non-Aryan peoples. From the Vedic epoch the Indian religions rapidly assumed varied forms. Earliest of these was Brahmanism, which is described in three chapters, followed by Jainism, Buddhism, and the numerous early and late sects of Hinduism, with the worship of Vishnu, Siva and the wild polytheism of later centuries. These are depicted in their chief traits and their historic connections pointed out with learning and clearness. The chapter on the religious traits of the present wild tribes is less satisfactory. Their faiths do not seem to be so familiar to the author, or he has less sympathy and less patience with them. The volume closes with a discussion of the probable influence which Indian religion and philosophy exerted on the analogous mental products of the early Semites and Aryans. It is natural that the author, steeped in the lore of Indian thought, should discover traces of it in the teachings of Jew and Greek; but it is likely that many will think he goes too far in deriving so much of the latter from the former.

It is a question of great moment to the historian of religions whether this long period of continued growth—at least three thousand years—developed in India higher conceptions of divinity and duty, a finer spirituality in the votary, a nobler sentiment toward his fellow man.

On this Prof. Hopkins speaks with clear conviction. He believes that tracing back the numerous branches of Hindu sectarianism to the Vedic period, one finds that throughout the long intervening time the direction has been true, and the higher aim 'steadily kept in view.' "Nor can one judge otherwise even when he

stands before so humiliating an exhibition of groundling bigotry as is presented by some of the religious sects of the present day" (p. 472).

In striking contrast to this is the conclusion reached by Mr. Phillips in his volume. In fact, the whole of it seems to be written for the purpose of proving the opposite opinion. He asserts that the farther back we go in the Vedic age, the purer and higher do we find the conceptions of divinity, man, duty, worship, a future state, sacrifice, etc. Hence he avers: "The development of religious thought in India has been uniformly downward—not upward—deterioration and not evolution." He explains this by the theory of a 'primitive divine revelation' granted to the Aryan forefathers, darkened and lost in their descendants. He shows a good reading knowledge of the Vedas in his discussions, but a total ignorance of the methods which now obtain among real scholars in treating the historical growth of religious phenomena. The need of such a work as that of Prof. Hopkins and of the series which it commences, is amply indicated by the appearance of such an essay as that of Mr. Phillips.

D. G. BRINTON.

SCIENTIFIC JOURNALS.

THE AMERICAN JOURNAL OF SCIENCE.

THE February number of the American Journal of Science opens with an article by A. M. Mayer, giving the results of an extended series of experiments upon the modulus of elasticity of bars of various metals and its variation with change of temperature. This modulus was obtained by transverse vibrations of bars of known dimensions and density. Rods of steel, aluminum, brass, glass and American white pine were employed. These were vibrated longitudinally, held between the thumb and forefinger, and the vibration-frequencies determined by the help of the standard forks of Dr. Koenig's tonometer in Paris. The application of Poisson's formula (shown to hold closely true by special experiments) gave the velocity of sound, and the modulus of elasticity was then calculated from the usual mathematical relation connecting these quantities. Special experiments were employed to give the coefficients of expansion, the densities, etc. The results are contained in an extended table and further represented

graphically in a series of plates. These show that the decrease of the modulus of elasticity of glass, aluminum and brass is proportional to the increase of temperature; straight lines referred to coördinates giving the results of experiments on these substances. The five steels, silver and zinc give curves, convex upwards, showing that the modulus decreases more rapidly than the increment of temperature; while bell metal alone gives a curve which is concave upwards; its modulus decreasing less than the increment of temperature. Bell metal was found to be an alloy peculiarly well suited for bells, as the intensity and duration of its vibration were the same at 50° as at 0°; all other substances showing a marked diminution of intensity and duration of sound at 50°.

In a special discussion as to the acoustical properties of aluminum, it is shown that this metal is not peculiarly *sonorous* as ordinarily believed. On the contrary, if a bar of aluminum and a bar of brass having the same length and breadth and giving the same note are struck transversely so that the bars have the same amplitude of vibration, the bars give equal intensity of sounds; but the bar of aluminum from its low density and because of its internal friction will vibrate less than one-third as long as the bar of brass. The peculiarity of aluminum consists in this fact, that its unusually low density (2.7), combined with a modulus of elasticity of only 712×10^6 , renders this metal easy to set in vibration; a transverse blow given to a bar of this metal causes it to vibrate with an amplitude of vibration greater than that which the same energy of blow would have given to a similar bar of steel or of brass.

It is true, however, that since aluminum gives, from a comparatively slight blow, a great initial vibration, and since its vibrations last for a short time, this metal is peculiarly well suited for the construction of those musical instruments formed of bars which are sounded by percussion and the duration of whose sounds is not desirable.

On the other hand, there is one serious objection to the use of aluminum in the construction of musical and acoustical instruments, and that

is the great effect that the change of temperature has upon its elasticity. If a bar of aluminum and a bar of cast steel be tuned at a certain temperature to exact unison, a change from that temperature will affect the frequency of vibration of the aluminum bar $2\frac{1}{2}$ times as much as the same change of temperature will affect the bar of cast steel.

A second physical article by Carl Barus gives the results of experiments carried on, with the aid of a fund from the Smithsonian Institution, on the curl aneroid. The special object of the investigation was to find what degree of constancy and precision could be obtained from a suitably modified Bourdon tube, or flattened tube coiled in the form of a helix. A similar tube had been used before successfully for high pressures with, however, certain limitations which do not exist in the case of low pressures, for which it is now designed, *e. g.*, when exhausted for use as an aneroid in registering small changes of atmospheric pressure. Experiments with simple curls are detailed, made very thin by dissolving away the walls in acid. Also other experiments with a counter-twisted system; that is, one supplied with a coiled spring placed above and *opposed to the flattened and exhausted curl. The results of the experiments with this form show that by it the hurtful effects of viscosity and changes of temperature can be reduced to a minimum, while the sensitiveness of the instrument is increased to a remarkable degree. G. W. Littlehales discusses from a mathematical standpoint the problem of finding an isolated shoal in the open sea which had been located by previous observation. He concludes that, under certain conditions named, there would be one chance in 6,173 of finding it. This explains why navigators often fail to find shoals shown on their charts. H. B. Kümmel gives a note on the glaciation of Pocono Knob (Monroe county) and Mounts Ararat and Sugar Loaf (Wayne county), in Pennsylvania, which have hitherto been regarded as having risen above the ice during glacial times. The author's observations, however, lead him to conclude that the ice probably covered the highest points of all these summits. T. L. Walker gives the result of a study of crystals of the platinum arsenide, sperrylite,

from Algoma, Ontario. He also adds some notes as to its occurrence, and notes the presence of iridium and osmium in the matte from the Murray mines, leading to the conclusion that these metals are sometimes constituents of the sperrylite. S. L. Penfield and E. H. Forbes describe the results of an investigation of the optical properties of the members of the chrysolite group of minerals as connected with their chemical composition. It is shown that the mean index of refraction, and also the strength of the double refraction, diminish with decrease in percentage of iron protoxide, FeO; on the other hand, the value of the optic axial angle ($2V$) increases. With the FeO about 12 per cent., $2V$ for yellow equals nearly 90° . Chrysolites containing less than 12 per cent. FeO have the crystallographic axis a for the acute bisectrix and are optically positive with dispersion $\rho < v$, and those richer in iron are optically negative with dispersion $\rho > v$.

The concluding twenty-five pages of the number are occupied with abstracts of papers in other journals, notices of books, scientific news, etc.

ASTROPHYSICAL JOURNAL, JANUARY.

Action of the Editorial Board of the Astrophysical Journal with Regard to Standards in Astrophysics and Spectroscopy.

The board of editors, who have had the question under consideration for the past year, have adopted for the magazine the following standards:

The Rowland scale of wave-lengths, the unit of wave-length to be Ångström's, the ten millionth of a millimeter, known also as the 'tenth-meter.'

The kilometer as the unit of measurements of motion in the line of sight.

The hydrogen lines to be designated $H\alpha$, $H\beta$, etc., beginning at the red end and continuing through the entire series. Maps of spectra will be printed with the red end on the right, and tables of wave-lengths with the shorter wave-lengths at the top.

The hope is expressed that the action of the editors will be concurred in by other astronomers and physicists, and adopted in their publications.

On the Spectrum of Clèveite Gas: C. RUNGE and F. PASCHEN.

The complete results of the writers' investigations are now published for the first time. Tables of wave-lengths and of double lines are given in full. When separated into six series, the lines show a striking regularity. Apparently there are two pairs of these series, each pair approaching a limit common to its components. From this and other reasons it is concluded that the gas consists of two elements, for the lighter of which the name Parhelium has been adopted. The hypothesis of two constituents is strengthened by the fact that vacuum tubes can be made which show the helium series much less brightly without a corresponding decrease of intensity in the parhelium series. Moreover, in the spectrum of the sun's limb the stronger of the helium lines are, according to Young, always seen, those of parhelium only about once in four times.

On the Gases obtained from Uraninite: J. NORMAN LOCKYER.

A paper read before the Royal Society containing some notes on the new gases recently obtained. These notes consist largely of comparisons of the spectra of these gases with those of the Sun and stars.

Outline of an Electrical Theory of Comets' Tails: REGINALD A. FESSENDEN.

The writer advances the theory that a comet's tail consists of negatively charged carbon particles driven from the nucleus by the action of the ultra-violet light of the Sun, its shape being the resultant of four forces: Gravitation acting towards the Sun, electric repulsion of the negative charge on the Sun, attraction due to the positive charge on the comet's nucleus, electrostatic repulsion existing between each negatively charged particle. The varied cometary phenomena are then examined in the light of this theory.

Photographic and Visual Observations of Holmes' Comet: E. E. BARNARD.

This is a résumé of observations made in 1892-93. The frontispiece is an enlargement of a photograph of the comet made soon after its discovery.

The Modern Spectroscope, XV.: F. L. O. WADSWORTH.

In this number of the series is suggested a form of mounting for the concave grating that will overcome its astigmatism so disadvantageous to certain forms of astrophysical work.

Minor Contributions and Notes.

Recent Researches Bearing on the Determination of Wave-lengths in the Infra-red Spectrum: JAMES E. KEELER.

Harvard College Observatory, Circular No. 3: EDWARD C. PICKERING.

THE PHYSICAL REVIEW, VOL. III., NO. 4., JANUARY-FEBRUARY, 1896.

On the Photometry of Differently Colored Lights, and the 'Flicker Photometer.' By F. B. WHITMAN. Based upon the peculiar effect of a flickering light upon the eye (discovered by Prof. Rood), Prof. Whitman has devised a new form of photometer for comparing the luminosities of colored lights and pigments. The construction of the instrument is briefly as follows: The colored surface to be studied is mounted obliquely upon a photometer carriage, and is illuminated from a source of light at one end of the bar. On the same carriage is mounted a white disk receiving light from the other end of the bar, and so arranged that it can be rapidly rotated. This disk is given such a shape that it hides the colored surface during half of each revolution. The eye of the observer thus receives light alternately from the colored surface and the rotating disk, and at low speeds there is a disagreeable flickering sensation. At high speeds the flickering is no longer noticed; strangely enough the sensation of color practically disappears at the same time, so that it is sometimes found impossible to tell what color is being experimented with. When the speed is sufficiently great the instrument can thus be used as an ordinary photometer, and makes possible a comparison of luminosities without annoyance from color differences.

Prof. Whitman describes a number of experiments which were made in order to test the instrument, and finds it much more reliable than the ordinary types of photometers.

The Chemical Potential of the Metals: By W. D. BANCROFT. This paper is devoted especially

to a discussion of the experimental data which have a bearing upon Nernst's theory of the E. M. F. of a voltaic cell. Dr. Bancroft is inclined to look upon certain aspects of this theory with considerable distrust. His conclusions may be summed up as follows:

1. The potential difference between a metal and an electrolyte is not a function of the concentration of the salt solution, nor of the nature of the positive ion, except in certain special cases.

2. It is a function of the electrode, of the negative ion, and of the solvent.

3. In aqueous solutions the potential difference is the sum of the term due to the electrode and the term due to the negative ion in the normal cases.

4. For most metals in most electrolytes the term due to the negative ion has the same numerical value and the same sign.

The tables accompanying this article, in which are collected the results of some ten different observers, will be found of especial value.

On the Freezing Points of Dilute Aqueous Solutions: By E. H. LOOMIS. The phenomenon of the lowering of the freezing point of a liquid by the presence of a dissolved salt has so important a bearing upon the theory of solutions that innumerable experimenters have made it a subject of study. That such determinations are extremely liable to serious error is shown by the disagreement between the results of different observers. In some previous work on this subject Dr. Loomis was led to make several improvements in methods and apparatus. The present paper gives the results of his new methods in the case of certain electrolytes, the salts studied being principally chlorides, carbonates and nitrates. In general the results may be said to be in fair agreement with the theory of electrolytic dissociation. With KCl and K_2SO_4 the agreement is complete. With half a dozen other salts it is not so good, but fairly satisfactory. K_2CO_3 and Na_2CO_3 show considerable discrepancies, which, however, may be due to uncertainty in the determination of the conductivities of these salts.

Dr. Loomis devotes considerable time to a discussion of the probable accuracy of his results, and in a minor article in the same num-

ber of the *Review* answers certain objections which have been raised against his earlier determinations.

A Comparison of two Concave Rowland Gratings: By ALICE H. BRUÈRE. Miss Bruère subjects the well-known irregularities in the intensity of the different spectra from a concave grating to a careful photometric study. The results show the same general character as those reached by Paschen by bolometric methods. The curves which accompany Miss Bruère's article show in a most striking manner the irregularities in intensity in different parts of the same spectrum, as well as in the spectra of different orders.

A New Apparatus for the Study of Color Phenomena: By E. R. VON NARDROFF. Mr. von Nardroff describes an ingenious apparatus to be used with a lantern for conveniently showing the various experiments dealing with color mixing, contrast, complementary colors, etc. The apparatus has been used by Mr. von Nardroff for several years and found satisfactory and convenient.

On a New Form of Water Battery: By L. W. AUSTIN and C. B. THWING. The writers have devised a cell which is constructed out of a homeopathic vial and strips of sheet copper and zinc, and which appears to possess considerable advantages. The chief novelty consists in the form of the two electrodes. Ease of construction, convenience in filling, and permanence of action are the advantages urged.

Books Reviewed: Daniell, *Principles of Physics*; Whetham, *Solution and Electrolysis*; S. P. Thompson, *Polyphaze Currents*; Palaz, *Industrial Photometry*; Walter, *Oberflächenfarben*; Clerke, *The Herschels and Modern Astronomy*.

SOCIETIES AND ACADEMIES.

JOINT COMMISSION OF THE SCIENTIFIC SOCIETIES OF WASHINGTON.

THE memorial meeting held by the Scientific Societies of Washington, on Wednesday evening, January 14th, at which addresses were made in honor of Dana, Pasteur, von Helmholtz and Huxley, was followed on the following evening, the 15th, by a meeting of the Joint Commission, in honor of the late Charles V. Riley, the entomologist. The memorial address by

Dr. G. Brown Goode will be published in this journal.

At this meeting the Joint Committee elected officers for the ensuing year, with the following result:

President—Gardiner G. Hubbard.

Vice-President—G. Brown Goode.

Secretary—Joseph Stanley-Brown.

Treasurer—Perry B. Pierce.

The Executive Committee elected will consist of the above and one member from each of the component societies, as follows: Anthropological, L. F. Ward; Biological, Dr. George M. Sternberg, U. S. A.; Chemical, Dr. E. A. De Schweinitz; Entomological, Wm. H. Ashmead; Geological, S. F. Emmons; National Geographic, G. K. Gilbert, and Philosophical, Prof. F. W. Clarke.

W. F. MORSELL.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON, JANUARY 4.

E. D. PRESTON read a paper on a new graphic method of reducing stars from mean to apparent places, which gave detailed exposition of a new graphical method of finding the apparent places of stars. The reduction was carried out by having the day numbers plotted on a scale sufficiently large to read two decimal places, and then multiplying these graphically by the star numbers which are calculated by construction on the same sheet. The calculation of these last quantities is facilitated in several ways. Two quadrants are drawn, and the right ascension and declination of the star to be reduced being selected, the simple trigonometrical functions are immediately read off from the figure.

For those terms where a product of functions appears, the method enables the operator to construct the quantity by different processes. That one is chosen which arrives at a resulting line lying at right angles to the day numbers already plotted. This makes their multiplication a very easy matter. In actual practice the construction lines shown on the diagram are of course not drawn. The whole sheet being divided into small squares, the computer is able to project the point visually, and to determine the intersections of the necessary constructions without actually drawing them.

The method has been principally used for checking the regular computation, and this can be done in less than one-half the time required to make the first reduction. But with a scale sufficiently enlarged there seems to be no reason why the system should not be used with entire success for a complete and separate solution.

January 18th the following papers were read: Dr. G. Brown Goode, on 'The Principles of Museum Administration;' Mr. Isaac Winston, on the 'Present form of precise levelling apparatus in use by the U. S. Coast and Geodetic Survey;' Mr. G. R. Putnam, on the 'Results of Recent Pendulum Observations.'

BERNARD R. GREEN,
Secretary.

CHEMICAL SOCIETY OF WASHINGTON, 83D REG- ULAR MEETING, THURSDAY, NOVEMBER 14, 1895.

THE President, Chas. E. Munroe, in the chair, with thirty-five members present. The following were elected to membership: H. B. Hodges, Allan Wade Dow, W. W. Skinner and F. B. Bomberger. Dr. Marcus Benjamin read a paper on 'The Smithsonian Institution's Contributions to Chemistry from 1846 to 1896.' He referred to the fact that Smithson in his time was considered as among the most expert of chemists in elegant analysis. This he thought had much to do with the provision made for a chemical laboratory in the original 'programme of organization of the Smithsonian Institution.' He traced the history of the laboratory, mentioning the chemists who have occupied it, among whom was J. Laurence Smith. The chemical publications of the Institution were reviewed, beginning with that of Dr. Robert Hare 'On the Explosiveness of Nitre,' in 1850, down to that 'On the Density of Oxygen and Hydrogen, and on the Reduction of their Atomic Weights,' by Edward N. Morley, in 1895. The lectures by Cooke, Johnson, Hunt and others were mentioned and the grants of funds to Genth, Gibbs and Morley for chemical research were described.

The work of Booth as shown in his 'Report of Recent Instruments in the Chemical Arts;' of Clarke in his 'Constants of Nature,' and of Bolton in his 'Bibliography of Chemistry,' as

well as the many indexes to chemical literature by Magee, Bolton, Traphagen, Tuckerman and others were mentioned and discussed. The paper was concluded with a full bibliography of the chemical papers published by the Smithsonian Institution.

Mr. Cabell Whitehead read some 'Notes on a recent visit to European Mints.' In the discussion of this paper mention was made of the explosions that occur commonly in lighting a 'Buffalo Dental Company's' muffler furnace, and Mr. Dewey said they could be avoided by raising the whole body of the furnace by a simple arrangement of movable levers and then slipping a lighted paper over the burners.

Under the title 'Calcium Phosphide,' Prof. Chas. E. Munroe described the process of manufacture which he invented and carried into operation at the United States Naval Torpedo Station in 1891. The novelty consisted in the use of the iron crucibles, in which quicklime was heated to redness, after which sticks of white phosphorus were added through an iron tube which penetrated the cover. The process was so simple that eventually it was carried on by unskilled laborers, and the phosphide which was then selling in the market for \$2.25 per lb. was produced at a cost of 20 cents per lb. It was manufactured for use in Automobile torpedoes while at practice, and was found so efficient that when a pound in its container was submerged in 18 feet of water it gave a flame 2 feet in height on the surface, which continued to burn for three hours.

A. C. PEALE,
Secretary.

BOSTON SOCIETY OF NATURAL HISTORY.

THE Society met December 18; one hundred and six persons present.

Mr. F. W. Crosby described a remarkable locality in Cephalonia where the water runs from the sea into the land at a rate varying from 4,000 to 10,000 cubic feet per minute. This immense quantity of water is utilized as power for mills, but what becomes of it is not known.

Prof. G. Frederick Wright discussed the present status of Glacial man in America. He showed an ancient chipped knife found by Mr.

Huston at Brilliant, Ohio, and gave additional evidence, the result of a renewed study upon the ground, to prove that the implement was not intrusive but was found in the undisturbed strata of the original terrace. Prof. Wright's paper was illustrated by a series of lantern slides.

Prof. H. W. Haynes reviewed the evidence of early man in America as presented by Mr. Upham and Miss Babbitt, and showed some of the rudely flaked quartzes found by Miss Babbitt, at Little Falls, Minn.

SAMUEL HENSHAW,
Secretary.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, JANUARY 7, 1896.

Some occurrences of Eruptive Granite in the Archean Highlands of New Jersey: By J. E. WOLFF.

Occurrences of eruptive granite have been described in the white limestone area from Franklin northeastward, to which the present crystalline condition of the limestone is ascribed as due to contact metamorphism. These occurrences lie in the valley at the west base of the Highlands. The object of this communication was to describe the occurrence of a large area of granite within the area of the gneisses themselves, lying near the west edge of the plateau formed by the Archean gneisses and nearly due east of Franklin. The area so far as determined is about six miles from north to south and two miles wide; the field evidence seems to prove its eruptive character through the bounding gneisses.

JANUARY 14, 1896.

1. *National Concentration of Ore Deposits:* By A. C. LANE. (To be published in the Engineering and Mining Journal.)
2. *Plains of Marine and Subaërial Denudation:* By W. M. DAVIS. (To be published in Bulletin of the Geological Society of America.)
T. A. JAGGAR, JR.,
Recording Secretary.

TORREY BOTANICAL CLUB.

THE annual meeting of the Torrey Botanical Club was held on Tuesday evening, January

14th. The reports of the officers and committees exhibited the most flourishing condition in the history of the Club. The following officers were elected for the ensuing year: President, Hon. Addison Brown; Vice-Presidents, T. F. Allen, M. D., and L. H. Lighthipe; Recording Secretary, Henry H. Rusby, M. D., College of Pharmacy, New York City; Corresponding Secretary, John K. Small, Columbia College, New York City; Treasurer, Henry Ogden, 11 Pine Street, New York City; Editor, N. L. Britton, Ph. D., Columbia College, New York City; Associate Editors, Emily L. Gregory, Ph. D., Anna Murray Vail, Arthur Hollick, Ph. B., Byron D. Halsted, Sc. D., A. A. Heller; Curator, Helen M. Ingersoll; Librarian, Wm. E. Wheelock, M. D.

The scientific paper of the evening, by Miss Alice M. Isaacs and Miss Marian Satterlee, and read by Miss Isaacs, was on the 'Anatomy of the Leaf of *Solidago Pauciflosculosa*.' The study had been suggested by Prof. Britton in order to throw light upon the generic position of the plant, a subject involved in some doubt.

The leaf was compared with that of the typical dicotyledonous plant and with other members of the genus *Solidago*. The points of difference noted are as follows: 1st, an unusual surface whose punctate appearance is caused by an irregular development of the parenchymatous tissue; 2d, the absence of palisade tissue characteristic of a dicotyledonous leaf. The depressions in the surface are found to be caused by the fact that the leaf is contracted just above and below the bundles, scarcely any mesophyll being found between the bundles and the epidermis. The blade expands between the bundles, and in these expanded parts the mesophyll is found. The epidermis following the outline of the leaf may be cut off in small patches instead of in a continuous piece as is usually the case.

Of the many species examined, *Solidago sempervirens* was the only one that at all resembled *S. pauciflosculosa*. The fact that *S. pauciflosculosa* is a shrubby plant, together with these leaf peculiarities, seem almost sufficient to justify Nuttall in classing this plant as a separate genus *Chrysoma*.

H. H. RUSBY,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of January 20, 1896, 23 persons present, Mr. C. H. Thompson exhibited specimens of a number of Lemnaceæ, and gave in detail the results of some recent studies which he had made on *Wolffia gladiata*, var. *Floridana*, from the sluggish streams of southeastern Missouri, and *Wolffia lingulata*, which he had collected in Kern county, California, last autumn. Both species belong to the subgenus *Wolffiella*, of which flowers and fruit are quite unknown. The species found in southern Missouri occurs associated with *Leitneria* and other distinctively Floridan forms, of which it is one, while the species collected in California seems to have been known heretofore only from central Mexico.

Prof. E. A. Engler, in continuation of his remarks at the last meeting, spoke of certain properties of the parabola, from which it resulted that from any point on the convex side of the evolute of a parabola three normals can be drawn to the latter; from any point on the evolute, two; and from any point on the concave side of the evolute, one. Suggestion was made of the probable bearing of this demonstration on other curves.

Dr. A. C. Bernays exhibited a slide of the epidermis of *Fritillaria*, exhibiting karyokinetic patterns.

WILLIAM TRELEASE,
Recording Secretary.

NEW BOOKS.

Die Chemie in Taglichen Leben. DR. LASSAR COHN. Hamburg & Leipzig, Leopold Voss. 1896. Pp. vii.+258. M. 4.

Chemistry for Engineers and Manufacturers. BE-TRAM BLOUNT and A. T. BLOXAM. London, Charles Griffin & Co.; Philadelphia, J. B. Lippincott Co. 1896. \$3.50.

Chemical Experiments. R. P. WILLIAMS. Boston and London, Ginn & Co. 1895. Pp. x.+102.

Die Spectralanalyse. JOHN LANDAUER. Braunschweig. Friedrich Vieweg & Sohn. 1896. Pp. 174.

The Child and Childhood in Folk Thought. ALEXANDER FRANCIS CHAMBERLAIN. New York and London, Macmillan & Co. 1896. Pp. x.+464. \$3.00.